Optimum fishing effort and economic rent: a case study of Cyprus

by
Rognvaldur Hannesson
Professor
Norwegian School of Economics
and Business Administration
Bergen, Norway

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

M-43
ISBN 92-5-102753-6

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying or otherwise, without the prior permission of the copyright owner. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

© FAO 1989

PREPARATION OF THIS PAPER

This document has been prepared as part of FAO's Regular Programme activities and is one in a series of technical papers relating to the PRACTICES OF FISHERIES MANAGEMENT. The paper illustrates methods for estimating economic rents and calculating economically optimum levels of effort. It, thus, provides a tool which countries can use for analysis of employment and efficiency objectives.

Distribution:

FAO Fisheries Department
FAO Regional Fisheries Officers
Directors of Fisheries
Selector SM
Author

For bibliographic purposes this document should be cited as follows:

Hannesson, R., 1988 Optimum fishing effort and economic rent: a case study of Cyprus. FAO Fish.Tech.Pap., (299):57 p.

ABSTRACT

This study provides a detailed analysis of the economic rent available in a particular fishery and demonstrates the method used for calculation of the rent. The case of the fisheries in Cyprus is used as a basis for the analysis.

The study begins with a discussion of the condition of open access to fisheries and the need for control over fishing effort. The three major techniques for controlling fishing effort are examined and it is concluded that, in the case of Cyprus, the best technique is a limit on the number of fishing units.

Based on a biological analysis which was undertaken previously, the study proceeds to estimate the costs of fishing and to calculate the amounts of economic rents in the fisheries at present. Estimates of the economically optimum levels of fishing effort are then provided and it is concluded that the economic optimum would occur if effort were significantly reduced. Measures that might lead to an economically optimum level of effort are then discussed.

TABLE OF CONTENTS

Page

1. INTRODUCTION 1

2. WHY FISHING EFFORT MUST BE CONTROLLED 2

2.1 The basic objectives of fisheries policy 2
2.2 Economic efficiency and the need to regulate fisheries 3
2.3 Resource scarcity and the maximization of rents 4
2.4 Changes in prices, etc. 6
2.5 Employment as an objective of fisheries policy 7

3. MEANS OF CONTROLLING FISHING EFFORT 8

3.1 Catch quotas 8
3.2 Licence limitation of fishing effort 10
3.3 A special resource tax on fishing 12

4. IMPLEMENTATION OF EFFORT LIMITATION SCHEMES 13

4.1 Buy-back schemes 14
4.2 The value of a fishing licence or quota 15
4.3 Transferability again 16

5. THE CYPRUS FISHERIES: AN OVERVIEW 18

5.1 The fish resources 18
5.2 The inshore fleet and the market structure 18
5.3 The trawl fishery: an important change in regulations 20
5.4 The increasing need for effort regulation 21

6. ECONOMIC RENT IN THE CYPRUS FISHERIES 23

6.1 Economic rent and the opportunity cost concept 23
6.2 Economic rent in the Cyprus fisheries, including trawling and swordfishing 24
6.3 Economic rent of the trawl fishery 27
6.4 Economic rents in the inshore fishery 30
6.5 Rents in the marketing sector 34

Page

7. OPTIMUM EFFORT IN THE CYPRUS FISHERIES 38

7.1 Maximum sustainable rent effort 38
7.2 Maximizing the present value of rents 43
7.3 The effects on yield and rents of achieving optimum effort 45
7.4 A gradual approach to optimum effort 46
7.5 The first step: stopping the expansion of effort 47

8. THE CONTROL OF FISHING EFFORT 47

8.1 Individual catch quotas 47
8.2 Boat licences 48
8.3 Limitation of effort through excluding occasional fishermen 52
8.4 Effort limitation through a buy-back scheme 53
8.5 Taxing the fishery rents 53
8.6 The need to specify licences with respect to time spent fishing 55
8.7 Area-specific licences 56
8.8 Reducing the trawling effort 56

9. REFERENCES 57

1. INTRODUCTION

This present study is the result of a mission to Cyprus undertaken for FAO in August 1985. The purpose of this mission was to give advice to the Cyprus Government with regard to optimum effort in the fisheries of Cyprus, and to calculate the economic rent obtainable in the fishery. A part of the background for this mission was the fact that the closed season in the trawl fishery had been extended, leading to improved yields and expanded effort in the inshore fishery. This made the need to control the effort in the inshore fishery all the more urgent.

This present paper is a slightly revised version of the original report to the Government of Cyprus. The emphasis here is on principles and methodology. We begin with a short review of the economic theory of fisheries management, discussing why, how, and for what purpose fisheries should be controlled. This discussion proceeds on the assumption that efficient allocation of resources is the primary objective of government policy. Even if there may be other objectives that a government wishes to achieve, focusing on economic efficiency has the advantage of providing a basis for evaluating other objectives and clarifying the costs of adopting these.

The pursuit of economic efficiency implies maximization of economic rent in the fishery. It is worth noting that the maximization of rent is not an objective in itself, but rather a consequence of desiring an economically efficient allocation of resources. This provides a justification for the emphasis on calculating economic rent in this study. Apart from this, economic rent can be used by government as a source of revenue, which makes economic rent an interesting subject in its own right.

Having discussed the need to control fisheries (Chapter 2), we then (Chapter 3) turn to the question how this may be accomplished. Three principal methods are identified; that is, individual catch quotas, licensing of fishing effort, and a special tax on fishing, and the relative merits of these methods are discussed. This leads on to a discussion of how a fishery regulation may be implemented in a way that satisfies the objectives of economic efficiency without jeopardizing the interests of fishermen (Chapter 4). This can be accomplished through allocating licences or fishing quotas to those who are active fishermen at the time the regulation is introduced, and then buying back quotas or licences to the extent required to achieve optimum fishing effort.

After this general introduction, we turn to the Cyprus fisheries as a case in point (Chapters 5-8). This analysis is, in part, an extension of a biological analysis by Garcia and Demetropoulos (1986) of the resource base of the Cyprus fisheries. After a brief overview of the Cyprus fisheries (Chapter 5), we proceed to estimate the costs of fishing and to calculate the economic rent in the fishery (Chapter 6). Having estimated the cost of fishing effort, we use the model of Garcia and Demetropoulos to find the economically optimum fishing effort (Chapter 7). This turns out to be considerably less than the fishing effort in recent years. We then (Chapter 8) discuss which measures appear to be most appropriate for the Cyprus Government to take, in order to improve the profitability of the fishery and, eventually, to maximize economic rent.

Presumably the Cyprus case could be useful as a reference for similar missions to developing countries. The report demonstrates how one may go about calculating optimum fishing effort and economic rent from a limited amount of data in a short period of time. Even if Cyprus is too advanced to fit the label "developing country", there are probably strong similarities between the fisheries in Cyprus and those of many developing countries. The resource base consists of a multitude of species with a high turnover rate, the fishery is conducted by small boats with a crew of one or two people using a simple technology, and the daily catch is small and is easily landed almost anywhere. The relatively abundant alternative employment opportunities for the Cyprus fishermen, especially the younger ones, and high prices of fish, would seem to be the main differences between the Cyprus fisheries and those of a developing country.

An important lesson of the Cyprus mission, and one that it is difficult to convey even if essential, is the importance of support on the spot. There is little that an expatriate who neither reads nor writes the local language can do unless adequate support is given by the locals. In this regard, Mr. Andreas Demetropoulos, Head of the Cyprus Department of Fisheries, and his staff were most forthcoming, digging up the available data, helping in making reasonable estimates when the figures were not there, and serving as interpreters when talking to fishermen on the wharf. Without this support, little would have been accomplished.

2. WHY FISHING EFFORT MUST BE CONTROLLED

2.1 The basic objectives of fisheries policy

What are the basic objectives of fisheries policy? Ideally these should be derived from economic and industrial policy in general, of which fisheries policy is only a part. What, then, are the objectives of that policy? On this there are two major schools of thought; one that might be called the "idealistic" school, and another which could be labelled the "empirical" school. The idealistic school, associated with traditional welfare economics, sees governments as guardians of the public interest, trying to promote the well-being of the citizens who elect them. The empirical school, associated with the so-called "public choice" literature, regards governments as consisting of "economic men" furthering their own ends, a process that may or may not promote the interests of the general public. Here we shall take the idealistic view and assume that it is the purpose of economic policy to further the well-being of the general public, as far as this is possible through economic means.

The last statement is a fairly general one, but allows us nevertheless to distinguish between two basic aspects of a policy designed to maximize economic welfare: (i) to make the best possible use of the productive resources at society's disposal, and (ii) to ensure that the result is equitably distributed. The former is concerned with the allocation of reources, the other with distribution of income. These are often referred to as allocation and distribution policies, respectively. In terms of fisheries policy, this amounts to ensuring that the right amount of productive resources (labour, capital, etc.) is allocated to the fishery vis-à-vis other sectors of the economy, and to ensure that fishermen get an equitable share of the national income.

2.2 Economic efficiency and the need to regulate fisheries

What, then, characterizes the right balance between the fishery and the rest of the economy, with respect to the allocation of resources? This we may find by using the marginalist principle. Assume that £1 worth of a commodity gives its buyer the same satisfaction, regardless of what the commodity is. Then, a bundle of resources producing £1 worth of fish must be capable of producing £1 worth of another commodity, in case it were transferred out of the fishery and into its best alternative use. If this were not so, a net gain could be accomplished by moving productive resources into or out of the fishery, depending on where their contribution is highest.

Referring to a unit of productive resources as a unit of fishing effort, the above translates into saying that the best possible allocation of resources is achieved when the marginal productivity of effort (the value of fish that a marginal unit of effort produces) is equal to the marginal cost of effort (the value that a marginal unit of effort would produce in its best alternative use). The standard Schaefer fisheries model, shown in Figure 1, provides a neat way of explaining this. The upper part of the figure shows the value of the sustainable catch, evaluated at a constant price. The sustainable marginal productivity of effort (mathematically, the first derivative of the catch value curve) is shown in the lower part. Optimal effort is E^o, i.e., the point where the marginal productivity of effort is equal to its marginal cost. (This analysis ignores discounting of future revenues, a topic we shall touch upon in Chapter 7.)

The need for fishery regulation arises from the fact that the fishery, if left to its own devices, has a strong tendency to expand fishing effort beyond the optimal level E^o. The reason is that each individual fisherman, or boat owner, perceives the value of catch per unit of effort as being his marginal productivity, rather than the sustainable marginal productivity of effort shown in Figure 1. Prospective fishermen, or boat owners, will therefore see opportunities for making a profit, as long as total effort is less than E_{eq}, referred to as equilibrium effort under free access.

It is important to understand clearly why there is a difference between sustainable marginal productivity of effort and the value of catch per unit of effort. Ignoring differences in skill, equipment, etc., a fisherman or a boat owner will expect to obtain the same catch value per unit of his effort as everybody else does. This, therefore, is his marginal productivity of effort as he perceives it. The sustainable marginal productivity is different, for the following reason. Increasing the amount of effort will, initially, increase the total catch. This, in turn, will deplete the fish stock, and the catch per unit of effort will be diminished. The net contribution of a marginal increase in effort thus is less than the catch per unit of effort; more precisely, it is equal to the catch per unit of effort less the decrease in the catch per unit of efffort, summed over all units of effort. The difference between the marginal productivity of effort, as the individual fisherman perceives it, and the sustainable marginal productivity of effort, is due to the scarcity of fish, i.e., that the amount available will become less as fishing effort increases.

2.3 Resource scarcity and the maximization of rents

The need to regulate fishing effort may thus be said to arise because the limitation in the productivity of fish stocks would not otherwise be taken into account. This limitation manifests itself through falling catches per unit of effort as effort is increased (in extreme cases, a near total depletion of fish stocks). Individual fishermen, or boat owners, have little incentive, however, to take this into account. A fall in the catch per unit of effort affects all fishermen to a similar degree. Hence, only one-nth part of the effect on the total catch will be felt by the fisherman or boat owner responsible for the increase in effort, n being the total number of fishermen or boats. If n is large, this effect is of little significance for each fisherman or boat owner, while it may be highly significant for the fishery as a whole.

This neglecting of the limitations in the productivity of fish stocks can be attributed to the fact that fish resources are common property instead of being privately owned. If a fish resource, such as the one depicted in Figure 1, were a private property and fishermen had to pay fees for using it, this would not happen. The maximum fee per unit of effort that the owner of the resource would be able to extract is equal to the difference between the value of the catch per unit of effort and the cost per unit of effort. This leaves fishermen with an income sufficient to cover their expenses, including the income they

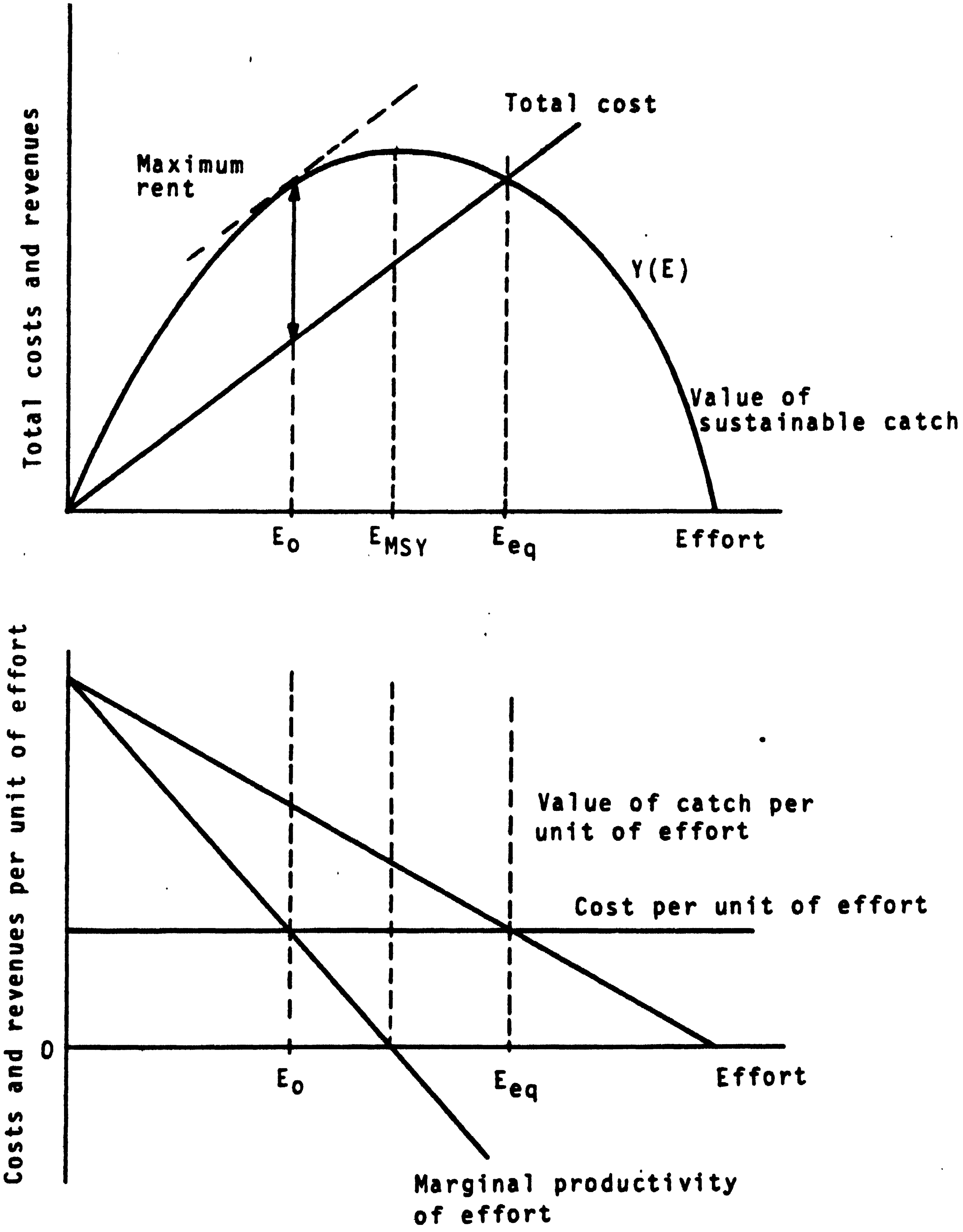

Total costs and revenues
Total cost
Maximum rent
Y(E)
Value of sustainable catch
E_o
E_{MSY}
E_{eq}
Effort
Costs and revenues per unit of effort
Value of catch per unit of effort
Cost per unit of effort
0
E_o
E_{eq}
Effort
Marginal productivity of effort

Figure 1. Conventional bio-economic model

would be able to get in an alternative occupation, but no more. The maximum amount that the owner of the fish stock would be able to extract through user fees occurs at the optimal level of effort, E^o. Here the difference between total revenue and total cost, which is equal to the total amount of user fees, is the largest possible. This is often referred to as economic rent or resource rent. The rent can be seen as a payment for the use of the limited productivity of the resource. Viewed from this perspective, rent is in fact a part of fishing costs. Hence the marginal cost of effort is equal to the value of the catch per unit of effort at the optimal level E^o.

The implication of this is that the optimum level of effort in a fishery can be found by maximizing the economic rent. It is important to note that maximization of economic rent is not an objective in itself; rather it follows from a desire to allocate the available productive resources in the best possible way. The resource rent can, if desired, be used as a source of income for the government, as will be discussed later. The government would then, as it were, be assuming the role of the resource owner discussed above.

2.4 Changes in prices, etc.

Up to now we have taken the price of fish, the cost of fishing effort, and the as yet unspecified biological parameters as being constant. We have studied a picture of the fishery as a bio-economic system which has come to rest. This, as most people will recognize, is not a very realistic picture of the world as it is. More often than not, fisheries are highly volatile and characterized by enormous fluctuations in catches or fish prices. Still, the bio-economic equilibrium we have been studying can be highly relevant. Provided the fishery tends toward this equilibrium, it will tell us something of interest about what kind of situation we may expect to find in the fishery, and how it will respond to changes in its economic and biological environment.

Consider, for example, what will happen if the price of fish or the cost of fishing effort change. Referring back to Figure 1, we note that a rise in the price of fish will "inflate" the yield curve, while a fall in the cost of effort will rotate the total cost curve downwards. Both of these will have the same qualitative impact in a fishery that has attained a bionomic equilibrium at E . Instead of breaking even, rents will now be obtained in the fishery. This, however, will not last in a free-access fishery. The rents will attract new entrants, or entice those who are in it already to expand their effort, and the rents will be eroded until they disappear completely. An opposite change in prices or the cost of effort will generate losses and lead to an exodus from the fishery.

In a controlled fishery, changes in the price of fish or the cost of fishing effort will raise or lower the economic rent, depending on the direction of the change. Such changes will also affect the location of the optimal effort (E_o).

Changes in biological parameters (growth rates of fish, recruitment of young fish, etc.) also affect the shape of the yield curve, and thereby the optimum and free-access equilibrium levels of fishing effort. Such changes are perhaps even more common than changes in prices and costs. The fact that such changes are beyond our control and unpredictable, except in a probabilistic sense, has implications for fisheries management, particularly how large the capacity of the fishing fleet should be. We will not consider these aspects in this paper.

2.5 Employment as an objective of fisheries policy

Employment is often cited as an important objective of fisheries policy. In the discussion so far it has not been mentioned at all. The reasoning above proceeded on the implicit assumption that there is no lack of employment opportunities; the problem at hand was the allocation of a limited amount of resources, labour included, among competing ends. An assumption of full employment does not seem to be unrealistic for the Cypriot economy; the rate of unemployment has varied between 1.8 and 3.3 percent in the period 1979 to 1983. Unemployment among university graduates, we are told, is perhaps the main unemployment problem in Cyprus, but not so for unskilled and semiskilled labourers. If an eventual decrease in the number of fishermen were not of a very large magnitude or particularly rapid, they could probably be employed in other sectors of the economy without much delay.

Even in economies with unemployment, it is not obvious that employment in fisheries, or any other industry for that matter, has any place as a primary policy objective. What has to be taken into account in such cases is that fishermen would not be likely to find employment if they left the fishery, and so would not produce anything else. The cost of their labour must be accounted for accordingly, at or near zero. This will increase the optimal level of fishing effort and thereby also employment in the fishery, compared with what would obtain if the cost of their labour were accounted for at the going wage rate. Employment as an objective in itself requires either that there be no other way of distributing income to those who are unemployed, or that undesirable social effects of unemployment make it necessary that every able person earn his or her living through some legitimate and ostensibly productive effort.

3. MEANS OF CONTROLLING

Given, then, that fishing effort must be controlled in order to achieve economic efficiency, in what way should this be done? There are three main methods by which fishing effort can be controlled in a manner that achieves, or comes reasonably close to achieving, economic efficiency. These are individual transferable catch quotas, licensing of fishing effort (usually boats), and a tax on fishing. Below we shall discuss each of these.

3.1 Catch quotas

The most direct approach to controlling the use of a fish stock is to limit the annual catch by a catch quota. This is, however, quite insufficient for ensuring economic efficiency; i.e., that the quota be caught as cheaply as possible. If nothing else is done, fishermen will compete with one another in getting the largest possible share of the quota, and they will invest in boats and equipment until the rate of return on that kind of investment is equal to what they might otherwise get through taking the best alternative investment opportunity available. This implies a waste of resources however, as long as no user fees are being charged for the fish resource. The resource rent will accrue to the fishermen and enhance their revenue, instead of being accounted for as a cost for using the limited productivity of the fish stock. Any resource rent will therefore appear as a return on invested capital, or an extra income to fishermen, over and above what it is possible to earn by investing or being employed in other sectors of the economy. Capital and manpower will therefore be attracted to the fishery until all rents have been eroded.

3.1.1 Transferability and efficiency

Dividing the catch quota into parts allocated to each fisherman or boat removes the incentive for each fisherman or boat owner to race for the fish. Such an allocation thus is less wasteful than having no control over the harvesting process, other than setting a total allowable catch. It is, however, not sufficient for ensuring a cost-minimizing way of harvesting. It may be, and quite often is, the case that there are more fishermen and boats around than needed to take the total allowable catch. Dividing the total allowable catch into individual quotas without allowing quotas to be transferred fails to provide an incentive to idle excessive manpower and boats. Transferability provides such an incentive, as the more efficient fishermen, or boat owners, are able to obtain a greater net revenue from a given catch quota than less efficient fishermen or boat owners. Hence the more efficient fishermen, or boat owners, will be able to pay some compensation to the less efficient ones for abandoning their quotas.

Individual transferable quotas provide an incentive for economic efficiency in yet another way. Under this system, each fisherman or boat owner has an incentive to use a cost-minimizing harvesting technology. A person holding a permanent or a long-term right to harvest a certain amount of fish has an incentive to acquire the type of boat and other outfit that allows him to take his quotas in the cheapest possible manner. To take full advantage of individual transferable quotas, the rights to holding such quotas must be valid for a period at least as long as the economic life of a fishing vessel.

We shall return to the question of transferability in the next chapter.

3.1.2 Fairness in the distribution of quotas

It is worth noting that a voluntary buying and selling of quotas implies a gain for both parties involved, while at the same time promoting the economic efficiency of the harvesting process. This has the important implication that the government involved in managing a particular fishery is able to achieve whatever it regards as a fair allocation of the fish resource through the initial allocation of quotas, while leaving it to voluntary transactions among individuals to achieve an efficient allocation. If it is necessary to reduce the total catch because of overfishing, the government may buy and retire quotas, as will be discussed in the following chapter.

3.1.3 Disadvantages of individual catch quotas

The disadvantages of individual catch quotas are primarily associated with the following three problems: enforcement, resource variability, and multispecies harvesting. With regard to enforcement, this depends critically on how and where the catch is sold. If the catch is taken by a multitude of small vessels and sold on the home market through a multitude of outlets, then individual catch quotas are going to be difficult to police. Every quota holder would have an obvious incentive to under-report his catches and, if this is easily accomplished, a quota system might simply push the fishing industry into the black economy and make a mess of controlling the total amount harvested. If not altogether impossible, enforcement is in any case going to be very costly under those circumstances.

Resource variability makes it necessary to revise annual or seasonal catch quotas continuously. If resource variability is such that the total allowable catch must be changed substantially from year to year or season to season, then individual fishermen or boat owners cannot be permitted to catch the same amount of fish each season or year. There are two ways of dealing with this. The management authorities can buy or sell quotas in order to attune the actual catch to the availability of fish at any time. Thus, while fishermen or boat owners would have the right to harvest a given amount of fish each year, they would be enticed not to exercise that right in poor years and offered the possibility of fishing more in good years. This, in effect, shelters fishermen from the risk associated with the variability of fish stocks. A potential problem with this method is that the buying and selling of quotas by the management authority might produce a financial deficit; quotas would be bought when fish are scarce and presumably expensive, while quotas would be sold when fish are plentiful and cheap.

The other method of dealing with variability in fish stocks is to allocate percentages of the total allowable catch to fishermen or boat owners. They would then have to figure out for themselves how large catches they could expect to take and what kind of boat and equipment their allocation could sustain. In this case the fishermen, or boat owners, would carry the full risk of fish stock variability themselves.

In multispecies fisheries, where each species cannot be targeted on, each boat owner would have to hold a portfolio of species quotas just to cover each trip. The administration of such quota portfolios might be a cumbersome undertaking, particularly for small, owner-operated vessels with limited administrative resources. An incentive to dump fish, for which there is no quota left in the portfolio, might easily arise.

3.1.4 Examples of individual transferable quotas

Individual transferable quotas have been implemented in a number of countries, but they are still more of an exception than a rule in the management of fisheries despite their positive implications for economic efficiency. New Zealand has probably proceeded further in this direction than any other country, having introduced individual transferable quotas for virtually all its fisheries. There are individual transferable quotas in certain fisheries in Australia and in eastern Canada. Iceland introduced boat quotas in its cod fishery some time ago. These quotas are transferable within certain restrictions, although transferability does not appear to have been a major part of the quota scheme. Norway has used vessel quotas in a number of fisheries, but these have in general not been transferable.

3.2 Licence limitation of fishing effort

This is a much more commonly used method for regulating fishing effort than individual catch quotas. The reason is, perhaps, that this is ostensibly an easier way. While catches can be under-reported or sold illicitly, given the right circumstances, a fishing boat is not easy to hide. On a closer examination, there are formidable problems with using licences, provided the objective is to achieve economic efficiency. The problem arises because fishing effort is multidimensional; a unit of effort, however it is being measured, is produced by applying equipment of various types; boats with different characteristics, engine and other mechanical devices, electronic equipment, fishing gear, and manpower.

To the extent it is possible to expand fishing effort along any of these dimensions independently of others, it will be necessary to control all these effort dimensions simultaneously to avoid distorting the cost-minimizing combination of the various components of fishing effort. This can be a cumbersome undertaking. For practical reasons, only one or a few easily observable dimensions of effort are usually subject to control. The efficacy of such controls depends on how easily effort may be expanded along uncontrolled dimensions. If this is difficult, then the licensing of one or a few easily observable dimensions of effort may indeed be a good solution. For example, when an effort licence gives the licencee the right to operate a fishing boat without any further qualification, one would expect the licencee to acquire a bigger boat if this is economical, thus expanding fishing effort along an unlicensed dimension (boat size). If, however, catches are unrelated to boat size, the licensing of boats only may be sufficient to achieve a reasonable degree of efficiency.

3.2.1 Transferability of licences

Making effort licences transferable does not promote economic efficiency quite as straightforwardly as transferable individual catch quotas. While it is true that those who are best able to utilize a fishing licence will be able to pay the highest price for it, this does not automatically imply an enhanced efficiency. The reason is that somebody's ability to get a higher return from a licence than somebody else may be due to an ability to catch more fish with the licence. This, however, would mean an increase in fishing effort and a depletion of fish stocks, an effect the licensing system was designed to prohibit. Allowing licences to be transferred therefore requires monitoring eventual changes in the level of effort.

There is still an argument, however, in favour of allowing transferability, as this means that the licences tend to be held by the most efficient fishermen, but the resulting increases in effort must be accommodated through retiring or buying back some licences (on this, see the next chapter). Technological progress may be similarly accommodated. The Norwegian purse seine fishery provides an illustrative example. Vessels in this fishery are licensed according to cargo capacity. Vessel owners were permitted to buy vessels and merege the licences of these with their own in order to accommodate larger and more efficient vessels (Hannesson, 1986).

Technological progress need not necessarily change the optimal size of vessels; it may simply improve the catching power of existing vessels and make obsolete a licensing system framed in terms of vessels and their characteristics. A case in point is provided by the use of monofilament nets, now being introduced in the Cypriot inshore fishery.

These nets increase the catching power of the vessels that adopt them, so that a universal adoption of these nets would require a certain reduction in the number of vessels that it is desirable to licence.

3.2.2 When are licences preferable to individual catch quotas?

Despite its drawbacks in terms of economic efficiency, a regulation system based on the licensing of vessels or their characteristics could, under certain circumstances, be preferable to a system based on individual quotas. These circumstances are associated with the previously listed drawbacks of an individual quota system, most notably the problems of enforcement and indiscriminate multispecies fishing. A fishing vessel is easy to observe, and so are its major characteristics, such as the power of its engine, its capacity, etc. Hence, if individual quotas are easy to evade and costly to enforce, a licensing system based on the most relevant vessel characteristics could in fact be superior. This is, of course, particularly so if it is difficult to expand fishing effort along the unregulated dimensions. A careful analysis of the enforcement problem, and the dimensions of effort, is thus required before deciding whether to opt for a licensing system or a system of individual transferable quotas.

In multispecies fisheries in which individual fish species are difficult to target on, licensing of effort may also be preferable to individual quotas, as it may be simpler to handle administratively, for fishery managers and boat owners alike. It may, however, be necessary to supplement a licensing system in a multispecies fishery with quota regulations for species that are particularly vulnerable to exploitation.

3.3 A special resource tax on fishing

A resource tax on fishing can be levied either on the catch of fish, in principle at any level down the chain from the wharf to the consumer, or on fishing effort. The multi-dimensionality of fishing effort, already discussed, implies that a tax on fish would be simpler, as it would otherwise be necessary to tax all the different components of fishing effort in a manner that does not distort the cost-minimizing combination.

The tax works through reducing the profitability of fishing. This provides a disincentive to investing in fishing boats and equipment and reduces the industry's ability to pay wages. Hence, the fishing industry will use less capital, manpower, and other inputs than otherwise. The problems with applying this method are several. First, it is difficult to calculate precisely the optimal level of the tax; this depends *inter alia* on parameters reflecting the productivity of the fish stock, the catching process, etc., none of which is known very precisely. Secondly, the response of the fishing industry, e.g., rates of investment or disinvestment, are not known with certainty. Some costly trial and error in the search for the optimum may therefore be involved. Thirdly, economic, technological, and environmental conditions are constantly changing, requiring corresponding changes in the tax rate.

But even if resource tax on fishing is not particularly relevant as the only device to keep fishing effort under control, it may still have its place as a supplement to the other two devices already mentioned, i.e., individual quotas or licences, which ever one decides to put in place. A special tax on fishing can be used to channel some of the rents being generated in the fishery through quotas or licences into the public purse. Whether or not it is desirable to do so is another matter, and one that involves value judgement. If the rents are not taxed, they will accrue unabridged to the fishermen, or possibly fishmongers, if the latter have some market power. Two arguments in favour of taxing rents may be noted, however. First a tax on rents can be used to buy and retire catch quotas or fishing licences, thus using part of the gains from a lesser fishing effort for achieving that reduction. Secondly, if rents are not taxed, the incomes and profits of fishermen and boat owners are likely to be appreciably higher than for comparable occupations. This is likely to create political pressure from outsiders for getting a share in the rents through new issues of licences or quotas, which would undermine the effort control system and defeat its purposes.

4. IMPLEMENTATION OF EFFORT LIMITATION SCHEMES

Introducing a new order of things, like individual fishing quotas or licence limitation, is not easy. Such an innovation introduces new restrictions on fishermen's behaviour, the outcome of which to some extent will be uncertain. Fishermen will, quite naturally, be apprehensive about such things, and it will take some persuasion and safeguards against a possible loss to get them to accept a new management regime.

Nevertheless, it can hardly be taken as an inviolable rule that any measure of interference in the economy should be so designed as not to offend anyone. Measures which can be designed to yield an overall benefit without making anyone worse off surely would seem more recommendable than others, however. There is a real possibility that the introduction of individual transferable quotas or licences in overexploited fisheries could be so designed as to satisfy that criterion. Furthermore, introducing a new management regime in a way that yields some benefit to fishermen enlists their support of the new measures and makes those measures easier to enforce.

4.1

A starting point for introducing fishing licences or quotas, in a way that benefits the fishermen who are active at that time, is to hand out quotas or licences in a way that allows fishermen to go about their business much as before. This has been done on several occasions when effort limitation schemes have been introduced. The licence limitation programme in the salmon fisheries on the west coast of Canada started with issuing licences to active fishermen. When the individual quota system in the inshore fishery of New Zealand got going, fishermen were given an initial allocation of quotas based on their actual catches over the last three years.

An initial allocation of licences or quotas based on recent performance freezes the situation as it is at the beginning of the regulation, but does little to diminish the actual level of effort. In a situation with overfishing this is not very satisfactory. But if no fisherman is to suffer any loss due to the introduction of licences or quotas, the reduction in effort must be accomplished through having fishermen part with their quotas or licences voluntarily. This can be done through buying quotas or licences from the fishermen at prices which they accept voluntarily. This is the so-called "buy-back" method of reducing fishing effort. By this method, an effort limitation scheme can be introduced without going against the interests of the fishermen active at that time.

4.1.1 Financing of buy-back schemes

What do fishermen gain from an effort limitation programme and how is a buy-back scheme to be financed? The answers to both these questions are closely related. The purpose of an effort limitation scheme is to improve the allocation of resources, a process that will generate rents in the fishery, as discussed in Chapter 2. If nothing else is done, these rents are going to benefit the fishermen who first obtained and who held on to their licences or quotas. Some of these rents could be used as a source of revenue for a fund to buy back and retire fishing quotas or licences. This revenue could be collected either through a fee on quotas or licences, or through a special tax on fish.

To get a buy-back scheme going, however, it will be necessary to advance some funds to it. No economic rent will be obtained unless fishing effort is reduced, and it will take some time for rents to emerge as this depends on the recover of the fish stock. But after these effects have materialized, the funds previously advanced to the buy-back scheme can be recovered through fees or taxes on those who remain in the fishery. Despite this the remaining fishermen would still retain a net gain. Indeed, the ability of a buy-back programme to be self-financing in this way is a test of whether an effort limitation scheme has been worthwhile.

4.1.2 Problems of finding the "right" price of a licence or quota

How, then, should quotas or licences be bought back? This can be done in two principal ways: either the management authority offers the fishermen a price for parting with their licence (quota), or it solicits tenders from fishermen; i.e., a statement of the price at which they are willing to surrender their licence (quota). While the licence limitation scheme in the salmon fisheries on the west coast of Canada was still effective, the government bought annually some vessels for retirement. Similar schemes exist in many countries; in Norway the government has offered owners of old purse seiners a certain sum of money for destroying their vessels. As there may be alternative uses even for old vessels, this seems going a bit far. The important thing is to retire the fishing licence and get the vessel out of the fishery.

Presumably the management authorities are interested in buying back fishing licences at the lowest possible prices which, however, leave those who surrender their licences with a sufficient compensation to do so voluntarily. Care must therefore be taken so as not to induce fishermen to overstate the compensation they require. This they would be likely to do if they thought there was a chance that such overstatement would result in a higher compensation for a licence. If, for example, a price is offered for a licence, with some prospects of that price being raised if too few show themselves willing to part with their licences, it is quite possible that some fishermen will hold out for a higher bid, even if they were happy with the first one. Similarly, asking fishermen to tender their licences, on the understanding that they will in fact get the price they state, is likely to lead to an overstatement of the price tendered. By stating a larger amount than he is willing to accept, a fisherman increases the compensation he will get, if he gets any, while at the same time decreasing the probability that his offer will be accepted. The balanced trade-off between these two opposite effects is likely to lead to a somewhat higher price being tendered than is in fact sufficient to compensate for the licence.

The scheme suggested for the buy-back of quotas in the inshore fishery of New Zealand tries to avoid this "overbidding trap". Fishermen were asked to tender their quotas on the understanding that the lowest bids would be accepted, whereas everybody would get the same price, equal to the last accepted tender. Under this system, a fisherman would, by overstating his quota price, simply risk that his offer would not be accepted without increasing his eventual compensation.

4.2 The value of a fishing licence or quota

What, then, determines the value of a fisherman's licence or quota; that is, the lowest price he is willing to accept for surrendering it voluntarily? The licence, or the quota, gives him a right to fish; in the absence of that right he would do something else. He would not surrender the licence unless he gets a compensation equal to the present value of the difference between the income he expects to get from fishing and the income he expects to be able to get by doing something else. The value fishermen put on their licences, or quotas, thus depends on their expectations about uncertain future incomes. This may make for nasty surprises as the future is revealed. The buy-back scheme of licences in the salmon fishery on the west coast of Canada ground to a halt because of overblown expectations on behalf of fishermen about their future earnings. Licences were bid up and their price went beyond the reach of the buy-back scheme. After a while, those who bought licences dearly on the basis of too optimistic expectations found themselves bankrupt.

This leads on to the question who really benefits from increasing the productivity of a fishery through restrictive licensing. When licences are given to those who are active in the fishery at the time the licensing scheme is introduced, that gain accrues to those who first got the licences. Those who want to enter the fishery after licence limitation has been introduced will have to buy a licence from someone who wants to leave. For somebody who wants to enter the fishery a licence will be worth an amount equal to the present value of the difference between what he expects to earn in the fishery and what he expects to earn otherwise. Competition to get into the fishery may be expected to enable those who want to retire from the fishery to sell their licences for what they are worth to new entrants. Thus the value of a licence will end up as a windfall gain for those who got the licences in the first round, while it is simply a cost for those who enter the fishery on the second round, a cost which they may be expected to be able to recover when they leave the fishery themselves.

Whether or not it is desirable that the rents in the fishery, as materialized in the value of licences, be collected by those who were active fishermen at the time licences were introduced, is a question of distribution, a political or moral question. If this is judged not to be desirable, the government may skim off some of the rent through a tax on or outright sale of licences. As licences in a free-access fishery have a low value, because most of the rent is dissipated through excessive fishing effort, the selling or taxing of licences is not a very realistic proposition at the beginning of an effort limitation scheme. If, however, such a scheme is successful, licences will gradually acquire a value. The option of charging a fee for licences, or quotas, should therefore be kept open at the outset. Alternatively, licences or quotas could be issued for a limited period of time and sold or auctioned off when the time for renewal comes up.

4.3 Transferability again

Above it has been argued that catch quotas and fishing licences should be transferable. The argument was based primarily on efficiency considerations; transferability implies that licences or quotas will be bought by those who are able to make the best use of them. There is a positive equity argument implied as well; freely transferable quotas or licences will be traded at a price which leaves neither side in the transaction at a loss. Hence an improvement in efficiency will be obtained without harming anyone, a truly positive gain in welfare.

Despite these persuasive arguments, opposition to transferability is frequent, both among government officials and fishermen themselves. It would be presumptious to dismiss such opposition as being the result either of ignorance or desire to regulate the industry in every detail. It appears that opposition to transferability is founded, primarily, on distributional arguments, namely that some individuals will be unduly enriched, while others will become impoverished. We have already discussed at some length how the benefits of a quota or limited entry system will accrue to those who initially get quotas or licences for free. It may indeed be considered inappropriate that those who happened to be active fishermen when the system was put in place, but did nothing to get it going other than to accept it, should be its primary benefactors. This argument says, in effect, that policy makers are unable to handle the initial distribution issue with due regard to its long-term consequences, and its weight is therefore rather limited.

The argument that buying and selling of quotas or licences is based on imperfect information is more important. The examples we went through earlier, showing how both buyers and sellers would benefit, depended implicitly on the assumption that both parties are aware of what the asset is worth. But information is not always equally perfect on both sides, and information about future events is simply not available. We have already mentioned how unrealistically optimistic expectations about the price of fish and the profitability of the fishing industry led to inflated licence values and, in due course, bankruptcies. Unrealistically pessimistic expectations would, by symmetry, lead to windfall gains for those who bought their licences (quotas) cheaply, on the basis of such expectations.

Certainly the fishery is not unique among business ventures in having to cope with the fact that the future does not turn out as expected. It can indeed be argued that fishermen should be left to themselves in exploiting the opportunities and shouldering the responsibilities that go with speculating in uncertain prospects. The problem is, however, that fishermen are, for political and social reasons, often considered to be a breed apart from the typical businessman. The problem becomes particularly difficult when fishermen belong to ethnic minorities, especially aboriginal ones, who, it may be argued, are selling their birthright for a dish of beans.

A persuasive argument in favour of transferability is that licences of quotas will be transferred anyway. Fishermen are usually permitted to transfer licences to next of kin, who then may become stand-ins for others, and aged fishermen could be persuaded to do so if transfers even to close relatives are prohibited. It is likely to be a better option to permit transfers to take place openly and legally and in a way that promotes efficiency. The openness and legality of the transaction permits licences to be taxed, as deemed justified for reasons of equity.

5. THE CYPRUS FISHERIES: AN OVERVIEW

5.1 The fish resources

The resource base of the Cyprus fisheries consists of a variety of species. Table 1 shows the average annual landings of the various species over the period 1974-83. The fish are typically fast-growing and short-lived. Hence the turnover rate of the fish stock biomass is high.

Two distinctly different fishing fleets exploit the fish resources of Cyprus. The inshore fishery is by far the most important one, contributing 70 percent or more of the yield taken from the Cyprus waters, in terms of value (the figure refers to the period 1980-83 and excludes trout farming and swordfishing). The remaining 30 percent are taken by trawlers. In addition, the Cypriot trawlers fish in international waters; in some years their catch in international waters has exceeded the catch in Cyprus waters. Table 2 shows the quantity and value produced by the Cyprus fisheries 1980-83.

5.2 The inshore fleet and the market structure

The inshore fleet consists of between 500 and 600 small, open boats, 20-40 ft long. Each boat is operated by one or two men. The boats make night trips, and return in the morning and land the catch in small fishing shelters scattered along the coast. A night's catch is typically rather small and consists of a quite large number of species; one perhaps extreme case that we happened to see was a fisherman returning with only one bucket (about 4-5 kg) containing fish of about 10 different species. According to the fishery statistics, the catch per working day in the inshore fleet was about 15 "okes" in 1983 (an "oke" is equivalent to 1.27 kg).

The fish is sold on the domestic market for direct consumption in households and restaurants, and its price is therefore relatively high. In 1984 the price of fish ranged from one Cypriot pound per oke for perca (Serranus scriba) and channos (Serranus cabrilla) to 6.10 pounds per oke for barbouni (Mullus surmulètus). One Cypriot pound is worth about two US dollars. Henceforth all value references will be to Cypriot pounds, unless otherwise state.

Table 1

Average landings in the inshore fishery 1974-83 by species

Species	Okes*
Barbouni	44 711
Strilia	30 360
Fangri	12 655
Synagrida	22 033
Lythrini	9 890
Fatsoukli	11 717
Mourmoura-Melana	4 435
Cephalos	2 007
Sorgos-Haratzida	41 399
Voppa	89 021
Milokopi-Siakos	1 937
Salpa	1 418
Mineri	8 979
Palamida	11 954
Orph.-Vlach.-Sphyrida	22 410
Skaros	14 075
Menoulla	11 857
Marida	51 192
Perka	4 211
Skorpios	6 788
Prosphygoulla	10 600
Channos	5 317
Astakos-Karavida	730
Garides	210
Octapodia	35 283
Sepia-Kalamari	30 824
Skyllos-Vati	10 461
Unsorted fish	78 159
Total	574 438

* An oke is equivalent to 1.27 kg.

Source: Annual Reports on the Department of Fisheries and the Cyprus Fisheries

Some fishermen sell their catches directly to households and restaurants, but most of the catches taken by the inshore fleet, and the entire trawl catch, is bought by some 24 fishmongers. The fishmongers have a trade association through which they cooperate to a quite high degree. The fishmongers do not compete with one another in buying fish from trawlers. Prices are set through negotiations between fishmongers and trawler owners, some of whom are fishmongers themselves. The catch is divided into 24 lots, one for each fishmonger,

Table 2

Quantity and value of landings 1980-83 by activity

Activity	1980		1981		1982		1983	
	Quant. tons	Value £'000	Quant. tons	Value £'000	Quant. tons	Value £'000	Quant. tons	Value £'000
Inshore fishery	762	1 292	810	1 635	858	1 826	1 221	2 460
Trawl fishery								
- local waters	250	262	238	258	266	298	440	475
- international waters	185	258	260	360	275	332	272	333
Swordfishery	77	61	86	76	121	144	32	58
Trout farming	30	50	35	80	45	108	45	108
TOTAL	1 304	1 923	1 429	2 409	1 565	2 708	2 010	3 434

Source: Annual Reports on the Department of Fisheries and the Cyprus Fisheries

which are allocated among the fishermongers through a lottery. Sometimes the fishmongers ask the trawlermen to stop fishing because of marketing problems. Prices in the inshroe fishery also appear to be set through some form of bargaining between the fishmongers and the fishermen's unions, but market conditions are said to have some influence on the price, making it drift a bit upwards from the listed prices when supply is low and downwards when supply is plentiful.

This indicates that fishmongers have some market power. It is difficult, however, to find evidence of economic rents being collected by fishmongers; the fact that so few fishermen and trawler owners sell their fish directly indicates that these rents are not extraordinarily high. One fisherman who sells his own fish said that doing so is no more profitable than selling to a fishmonger; even if the price is higher when bypassing one link in the sales chain, this gain is generally cancelled by the difficulties in selling all the catch at certain times.

5.3 The trawl fishery: an important change in regulations

The number of trawlers is limited by law. Presently only eight trawlers are permitted to fish in Cyprus waters. In addition, two trawlers fish only in international waters, which brings the total number of trawlers up to ten. Each trawler has a crew of eight. In a number of cases some of the crew members are Egyptians hired on contract.

In 1982 new regulations were implemented in the trawl fishery. The engine power of each vessel was restricted to 250 hp. More importantly, perhaps, the closed season was extended from four to five months, to include October in addition to the period June-September. The importance of extending the closed season lies in the fact that the trawl fishery was to a high degree based on juvenile fish, particularly of the species Maena smaris. Extending the closed season to include October would, it was alleged, substantially increase the catch by making better use of the growth potential of the juvenile fish.

This prediction was confirmed by experience. In the years 1978-82 the trawl catch had declined at an annual rate of 17 percent. The 1982-83 season showed a 40 percent increase in the catch, compared with the previous season, despite the shortening of the open season by one month. In 1983-84 the catch rose again by 40 percent (Garcia and Demetropoulos, 1986).

The impact on the inshore fishery was no less important. From having been more or less constant since 1980, the catch per day suddenly jumped by about 40 percent in 1983, and has stayed high ever since. Again the reason is a higher survival rate of juvenile fish and a better utilization of their growth potential.

5.4 The increasing need for effort regulation

The increase in the catch per unit of effort (catch per day) in the inshore fishery appears to have had precisely the effect described in Chapter 2. Improved profitability apparently attracted new entrants into the inshore fishery and enticed those who were part-time or occasional fishermen before to become full-time or part-time fishermen. Tables 3 and 4 show the number of vessels and working days in the inshore fishery over the period 1979-84, and the changes in these. In 1980/81 to 1982/83 the number of working days increased at a rate of 6-9 percent a year, jumping to an increase of 19 percent from 1983 to 1984. The number of fishing boats increased by 15 percent from 1983 to 1984, more than in any other year in the period 1979-84.

In order to prevent the gains from improved fish stock management being eroded, the increase in fishing effort would have to be stopped or perhaps rolled back. In the following chapters an attempt is made to calculate the optimum level of effort in the inshore fishery and the amount of economic rent that would be generated in an optimal fishery. We then discuss how an optimal level of effort in the inshore fishery could be achieved.

Table 3

Effort in the inshore fishery 1979-84

	1979	1980	1981	1982	1983	1984
Number of inshore fishing boats						
- full time	190	184	172	174	190	210
- part time	68	76	84	94	106	115
- occasional	159	187	160	197	181	223
Total	417	447	416	465	477	548
Total number of working days, inshore fishery	51 581	51 199	54 326	58 685	63 688	75 609
Average catch (kg) per boat per day, inshore fishery	10.44	11.91	11.93	15.0	19.67	19.66

Source: Annual Reports on the Department of Fisheries and the Cyprus fisheries, various years

Table 4

Inshore fishery year to year changes in effort

	1979/80	1980/81	1981/82	1982/83	1983/84
Number of fishing boats					
- full time	-6 (-3%)	-12 (-7%)	2 (1%)	16 (9%)	20 (11%)
- part time	8 (12%)	8 (11%)	10 (12%)	12 (13%)	9 (8%)
- occasional	28 (18%)	-27 (-14%)	37 (23%)	-16 (-8%)	42 (23%)
Total	30 (7%)	-31 (-7%)	49 (12%)	12 (3%)	71 (15%)
Total number of working days	- 382 (-1%)	3 127 (6%)	4 339 (8%)	5 003 (9%)	11 921 (19%)

6. ECONOMIC RENT IN THE CYPRUS FISHERIES

We now turn to examining the profitability of the Cyprus fisheries. Given that there has been free access to the inshore fishery, theory tells us not to expect any significant economic rents there. On the other hand, the extension of the closed season in the trawl fishery has raised the catch per unit of effort, which should have generated some economic rents in the fishery.

In order to calculate economic rent, it is necessary to know, or to estimate, revenues and costs. The Department of Fisheries collects data on catches and prices of fish, from which it is possible to derive fairly accurate estimates of revenue. The information on costs is less comprehensive, and also less reliable. Furthermore, the opportunity cost concept relevant for calculating economic rent implies that cost figures, as they appear on the books of boat owners and fishing firms, are not always appropriate. Our calculations of fishing costs are partly based on information about particular vessels or aggregate cost data, partly on what appear to us to be reasonable assumptions. On the basis of our cost estimates we then calculate the optimum effort, using Garcia and Demetropoulos' productivity model for the Cyprus fisheries (Garcia and Demetropoulos, 1986). This latter analysis will be presented in the following chapter.

6.1 Economic rent and the opportunity cost concept

Before we present our estimates of economic rent, some clarification is needed in order to explain the relevant cost concept and our cost estimates. As explained in Chapter 2, economic rent is the difference between the total revenue yielded by fishing effort, and the cost of fishing effort calculated as the value of goods and services that the resources used in the fishery (fishing effort) would produce if used in an alternative way. This is the opportunity cost concept. Hence we need to measure costs in the fishery in a way which shows the value that capital, manpower and other factors of production would produce if used for purposes other than fishing.

Inputs such as fuel, nets, etc., hardly represent any major practical problem with regard to measuring their opportunity cost. For such inputs there usually exist market values which can be taken to represent their value if used for some other purpose than fishing. The main problems arise in accounting for the costs of manpower and capital. The wage rate does not automatically reflect the opportunity cost of labour. Workers who are unemployable outside their particular industry are not rewarded with a zero wage, even if their opportunity cost is zero. This makes the going wage rate useless as a measure of the opportunity cost of labour in economies with high unemployment and for persons unemployable outside their trade. For Cyprus it seems reasonable to assume both full employment and employability of fishermen, or a substantial number thereof, outside their trade. Hence we have assumed an opportunity cost of labour that is close to the going wage rate in sectors where it seems likely that fishermen would alternatively be employed.

The opportunity cost of capital has two components: real depreciation and an opportunity cost of investment. In order to maintain his capital stock intact, an investor must be compensated for the wear and tear of his physical capital. This is the purpose of the depreciation allowance. But more is needed if the full opportunity cost of capital is to be accounted for. The purpose of investment whether from a private or a social point of view, is more ambitious than simply keeping the capital stock intact; in addition it is desired to get some return over and above what is needed to maintain the capital stock. Such opportunities usually exist. Hence, the opportunity cost of investing in the fishing industry is the net rate of return that could be earned on the best alternative investment. This is the alternative rate of return, which must be added to the depreciation rate to obtain the full opportunity cost of capital.

We are not aware of any studies of the alternative rate of return on capital in the Cypriot economy. Noting that it is a growing economy with full, or nearly full, employment, the alternative rate of return is likely to be quite high. Assuming 10 percent, as we shall do, would appear to be cautious.

As to the rate of depreciation, we shall use a depreciation formula employed by the Department of Fisheries in connection with its insurance scheme for inshore vessels. For the aggregate fishery and the trawl fishery we use a depreciation rate of 8 percent of current value. This is the average depreciation rate for inshore vessels, obtained when using the Department's formula.

Below we present three sets of calculations of costs and economic rent, one for the trawl fishery, one for the inshore fishery, and one for the whole fishery (including swordfishing and trawling in international waters). As these are to some extent based on different sets of data, they can be used as a check against one another.

6.2 Economic rent in the Cyprus fisheries, including trawling and swordfishing

Table 5 presents the calculation of economic rent in all of the Cyprus fisheries taken together. Before discussing the results, some explanation of the various entries in the table are called for.

Revenues do not include trout farming or sponges (source: Annual Report on the Department of Fisheries and the Cyprus Fisheries, 1984, Table 2). Running costs include fuel and oil, spare parts, ice, and repairs. These cost data have been reported to the Department of Statistics and Research by the Department of Fisheries. There is

Table 5

Calculation of economic rent in Cyprus fisheries, using aggregate data

	1983 £	1984 £
Revenues	3 326 315	4 328 950
less running costs	185 900	214 000
less cost of fishing gear	298 357	346 800
less labour costs	2 528 640	3 121 260
less cost of capital	198 000	248 220
Economic rent	115 418	398 670
- as percent of gross revenue	3%	9%
Value of capital stock:		
- trawlers	600 000	600 000
- inshore boats	500 000	779 000
	1 100 000	1 379 000
Gross return on capital (economic rent + capital costs - value of capital)	28%	47%
Value of capital absorbing all economic rent (economic rent + cost of capital - 0.18)	1 741 211	3 593 833
less value of trawlers	600 000	600 000
	1 141 211	2 993 833
- as percent of value of inshore vessels	228%	384%

reason to believe that these figures underestimate the actual costs. On the basis of interviews with captains and owners of some trawlers, and assumptions about fuel consumption of trawler engines, we have concluded (see next section) that the trawlers incur fuel costs and ice costs of £ 189 000 and £20 000 per year (1984), respectively. The fuel cost and ice cost figures reported for the entire fleet in 1984 were £156 000 and £10 000, respectively (only the trawlers use ice).

Cost of fishing gear does not appear to be included in the running costs reported by the Department of Fisheries. We have calculated these costs as follows. The average annual cost of fishing gear for a sample of 15 full-time inshore boats was close to £ 900 in 1984 (see section four of this chapter). This we have multiplied by the number of boats (Table 3). The part-time boats were assumed to incur 75 percent of the cost of full-time boats and occasional boats 25 percent (the Department of Fisheries assumes that part-time boats are operated at 75 percent and occasional boats at 25 percent of the time of full-time boats; cf. the Department Report on the Cyprus fisheries, 1983). The cost of fishing gear was assumed to have been £ 3 000 per trawler in 1984 (see next section) and about 5 percent lower in 1983.

Labour cost has been calculated on the basis of the opportunity cost principle. We have assumed that fishermen could alternatively be employed in agriculture, or as labourers. According to Statistics of Wages, Salaries and Hours of Work, October 1984, p. 11 (Department of Statistics and Research), the average monthly earnings for agricultural, animal husbandry and forestry workers (occupational group 6), and production and related workers, transport equipment operators, and labourers (occupational groups 7, 8 and 9) were as follows (men only):

	1983	1984
Group 6	247 (302)	266 (325)
Groups 7/8/9	268 (327)	286 (349)

Numbers in parenthesis include a 22.1 percent employers' contribution to social security funds.

On the basis of this information, we assumed an opportunity cost of labour of £ 320 per month in 1983, and £ 340 per month in 1984 for the inshore boats. The opportunity cost of labour in a full employment economy must include all employers' expenses, since the value produced by labour must be at least as high as this if the hiring of labour is to be worthwhile for the employer. To calculate the total opportunity cost of labour, the annual cost per labourer was multiplied by the number of fishermen (Table 3), using the earlier stated assumption about how much of a full year's occupation part-time and occasional fishermen represent. For the labour cost of trawlers, see next section.

The value of the capital stock of the inshore fleet is based on insurance values. The inshore vessels are insured in a scheme operated by the Department of Fisheries. Less than a half of the inshore boats are insured, but these are mostly full-time boats and the more expensive ones. We have used the insurance value of the inshore boats, except for those which are insured for £ 10 000, the maximum insurance value allowed. For these boats we have used the market value, as estimated by the Department of Fisheries.

The insurance value of the inshore fleet is considerably higher for 1984 than for 1983. This is mainly due to more boats entering the insurance scheme. Regarding the assumed value of the trawler fleet, see next section.

The cost of capital has been set at 18 percent, 10 percent assumed alternative rate of return on capital and 8 percent rate of depreciation. The average rate of depreciation for a sample of 10 inshore vessels was 8-9 percent (see section four of this chapter). The trawlers are 21-42 years old, equipped with 11-25 year old engines, all of which points to an extraordinarily long economic life.

The results reported in Table 5 indicate that some economic rent was obtained in the fishery both in 1983 and 1984; the figures show economic rent as having been 3 percent of gross revenue in 1983 and 9 percent in 1984. As already indicated, there is some reason to believe that these figures are too high. The running costs reported by the Department of Fisheries seem to be too low and the capital value of the inshore vessels is underestimated. In Table 5 there are figures showing how much the value of the inshore fleet would have to be raised in order to absorb the entire economic rent as a capital cost. These figures are 128 and 284 percent for 1983 and 1984, respectively, which appears to be much too high. An underestimate of the capital value thus would not alone appear to account for the economic rent emerging from our calculations, but together with an underestimate of running costs it could possibly do so for 1983. We conclude, therefore, that the Cyprus fishery was close to breaking even in 1983, while it yielded some economic rent in 1984.

6.3 Economic rent of the trawl fishery

Next we shall look at the profitability of the trawl fishery and the inshore fishery separately, beginning with the trawl fishery. While data on revenues are available in the annual reports of the Department of Fisheries, cost data are not easily obtained. We have attempted to construct cost figures for an average Cypriot trawler, based on interviews with some captains and owners of trawlers and assumptions about fuel consumption of engines.

Table 6 shows the calculation of economic rent in the trawl fishery. Again we explain the various entries in the table before discussing the result. The average revenue was calculated from the Annual Report on the Department of Fisheries and the Cyprus Fisheries, 1984, Table 2. This figure does not include revenue from swordfishing.

Table 6

Estimation of the economic rent of an average Cypriot trawler in 1984

Revenue	73 500
less cost of fuel	18 900
less cost of ice	2 000
less cost of gear	3 000
less maintenance cost	5 500
less cost of labour	25 200
less cost of capital (18% of 60 000)	10 800
Economic rent	8 100
- as percent of gross revenue	11%
Gross rate of return on capital (10 800 + 8 100 ÷ 60 000)	32%
Value of capital absorbing all economic rent (10 800 + 8 100 ÷ 0.18)	105 000

The cost figures are in part based on interviews with some trawler owners and captains, and in part on our own assumptions, as explained below.

In calculating labour costs we must take account of the fact that the trawlers are laid up for a part of the year. We have assumed that the trawlers fish for eight months a year on the average, excluding the swordfish fishery. The basis for this assumption is the following. The number of trawlers fishing each month in Cyprus and international waters is listed in the Annual Report on the Department of Fisheries and the Cyprus Fisheries. Adding the number of active trawler months each year and dividing by the theoretical maximum (120) gives an activity index for the trawler fleet which, after multiplication by 12, gives the average number of months a trawler has been fishing. This produces a trawling season of 8.4 months in 1983 and 7.1 months in 1984. During the idle period the crew is dismissed, except for the captain and one additional member who are hired for the whole year.

Most of the crew, except the captain and one additional member, are Egyptians. Reports on the monthly wage of the expatriate crew members ranged from £ 180 to £ 400 per month, excluding fringe benefits. We have assumed a monthly wage of £ 300 and an employment period of eight months for six crew members. The remaining two, we have assumed, are hired on an annual basis. One captain was reported to receive a monthly wage of £ 500 plus a bonus of £ 1 per box of fish. Another captain was reported to get a monthly wage of £ 300. This captain owns a share in his vessel. Regarding the bonus as a profit-sharing arrangement, it seems reasonable to assume an annual wage cost of £ 6 000 for a trawler captain. For the other Cypriot crew member we assume a monthly wage of £ 400 over 12 months. This adds up to a total wage cost of 8 x 6 x 300 + 6 000 + 12 x 400 = £ 25 200.

The capital value of the boat is based on interviews with trawler owners and other knowledgeable people. One trawler owner to whom we talked had recently bought a used vessel from another Cypriot for £ 62 000. The value of the Cypriot trawlers was generally reported to be £ 60 000-70 000, with one trawler value put as low as £ 40 000. Most of the trawlers are not insured; one is fully insured for £ 70 000, another is insured for £ 20 000, while its market value is put at £ 40 000. We assume an average value of £ 60 000.

Two trawlers were reported to incur maintenance costs of £ 4 000-5 000 every year. In addition, less frequent overhauls will be needed every now and then; the owners of a boat with a new engine expected that a major overhaul costing about £ 5 000 would be needed after five years. We assume a maintenance cost of £ 5 500 per year on the average.

One trawler fishing in international waters makes about 27 trips per year, and uses ice for about £ 200 per trip, which comes to £ 5 400 per year. Another trawler, fishing in Cypriot waters only, was said to incur ice cost of around £ 150 per month. We assume that the cost of ice is £ 2 000 per year on the average.

One trawler fishing in international waters needs new ropes and wires every one and a half months, for about £ 500 each time. This comes to £ 3 000 for the nine-month period this trawler is active. Adding a cost of two sets of nets needed each year brings this figure to £ 4 500-5 000 each year. Another trawler was reported to need a new net every year, if no gear damage occurred. A third boat was reported to incur a cost of £ 2 000 per year for nets and ropes. We assume a cost of fishing gear of £ 3 000 per year.

The fuel cost was calculated as shown in Table 7.

The result in Table 6 indicates that the profitability of the trawler fleet in 1984 was quite good. The calculations show a gross rate of return on capital of 32 percent, which does not square too badly with a remark by one trawlerman that the cost of a trawler ought to be recouped in two years! The economic rent of an average trawler was found to be 11 percent of gross revenue.

Table 7

Fuel cost of the Cyprus trawler fleet (10 trawlers)

	No. of working days	Fuel consumption, gallons per day	Total fuel consumption
Day trips	748	102.85	76 932
Two days trips	500	162.44	81 221
International waters	535	293.75	157 156
			315 309 gal
			x 60 cents
			£ 189 186

The impression of a high profitability given by the result in Table 6 may be too favourable, however. The capital value of the trawlers is rather low, reflecting their high age. It is open to doubt whether these profits are in fact high enough to justify a renewal of the fleet, other than through second-hand vessels; a capital value of about £ 100 000 per trawler would absorb all the economic rent as a capital cost. The value of a new trawler of the kind used in Cyprus is probably higher than this, possibly twice as high.

6.4 Economic rents in the inshore fishery

Finally, we consider the profitability of the inshore fishery. For this purpose two sets of data samples were provided by the Department of Fisheries, a sample of cost and value data for 15 vessels, and a sample of revenue data from 45 vessels. Unfortunately, these samples overlap only to a very limited degree; that is, four vessels. We have, however, elected to present the data for these four vessels separately. All of these vessels reported a high number of working days and thus appear to have been operated on a full-time basis.

Table 8 shows the economic rent of the four inshore boats, for which the cost and revenue data samples overlap. Some comments are called for to explain the estimation of costs and depreciation. Fuel costs are based on assumptions of eight working hours per day, a fuel consumption of 3/4 gallons per hour, and a price of 60 cents per gallon. For costs of nets and gear and repairs, see Table 14.

Table 8

Revenue and costs of four inshore boats, 1984

	FL 482	FL 461	FL 600	FP 518
Number of working days	264	281	211	187
Revenue	13 207	12 287	10 592	14 322
Costs:				
Fuel	950	1 012	760	673
Nets and gear	800	900	1 500	2 000
Repairs, etc.	460	460	460	420
Depreciation (see Table 9)	515	406	452	408
Labour cost	8 160	8 160	8 160	8 160
Opportunity cost of capital	558	468	557	503
Rent (revenue less costs)	1 764	881	-1 297	2 158
- in percent of revenue	13%	7%		15%

Table 9

Value and depreciation of four inshore vessels, 1984

	FL 482	FL 461	FL 600	FP 518
Hull	1 500	1 950	2 960	2 630
- depreciation	(94)	(122)	(185)	(164)
Engine	3 060	1 610	1 710	1 410
- depreciation	(311)	(164)	(174)	(143)
Hauler	290	290	210	300
- depreciation	(30)	(30)	(21)	(30)
Echosounder	230	230	90	80
- depreciation	(29)	(29)	(11)	(10)
Various equipment	500	600	600	600
- depreciation	(51)	(61)	(61)	(61)
Total value of capital	5 580	4 680	5 570	5 030
- depreciation	(515)	(406)	(452)	(408)
- as percent of total capital	9%	8%	8%	8%

Labour cost is calculated on the basis of an opportunity cost of £ 340 per month, as explained in the previous section. It is assumed that there are two men on each boat. Since we consider the depreciation of capital separately, opportunity cost of capital reflects here the alternative 10 pecent rate of return if capital were invested in a different way.

The depreciation figures in Table 8 are taken from Table 9. These are derived as follows. In calculating the value of capital equipment, the Department of Fisheries uses the formula $V_t = R^t V_o$, where V_o is the cost of new equipment at current prices, t is the age of the equipment, $R = a^{1/v}$, where v is the length of the time period over which the equipment depreciates, and a is the value of the equipment at the end of that period, expressed as a fraction of its purchasing price. Currently, the Department uses the value $a = 0.2$. From this formula we can find the rate of depreciation, $(V_{t+1} - V_t)/V_t = 1 - R$, and use this to find the actual depreciation, knowing the current value of the equipment as estimated by the formula. The length of the depreciation period is as follows:

Hull:	Boats < 22 ft:	20 years
	Boats 23-30 ft:	25 years
	Boats 31-40 ft:	30 years
Engines:	< 35 hp:	15 years
	> 35 hp:	20 years
Radiotelephones and haulers:		15 years
Echosounders:		12 years

For miscellaneous other equipment (anchor, ropes, lights, etc.), we have assumed a depreciation period of 15 years.

Table 10

Calculation of economic rent from two samples of inshore vessels, 1984

Average number of working days	191
Average revenue	9 362
less fuel costs	688
less gear costs	926
less repairs, etc.	466
less depreciation (see Table 11)	497
less labour cost	6 256
less opportunity cost of capital	596
Economic rent	-67

Table 10 summarizes the calculations of economic rent from the samples of revenue and cost data. The data from these samples, and some calculations on which the figures in Table 10 are based, are provided in Tables 11-14.

The average revenue has been calculated from a sample of 45 vessels, shown in Table 12. Fuel costs were calculated as above. For gear costs and repairs, see Table 14.

The number of working days varies considerably among the vessels in the sample (see Tables 12 and 13). In Table 13 we have divided the boats into groups, on the basis of the number of working days, and made assumptions as to what percentage of full-time fishing each group of boats represents. The number of full-time man-years per boat is 1.53 on this basis. This, multiplied by the opportunity cost of a man-year of labour (£ 4 080) gives the opportunity cost figure of labour shown in Table 10.

Table 11

Average value and depreciation of a sample of 15 inshore vessels (cf. Table 14)

Hull	2 846
depreciation (v = 25)	(177)
Engine	1 895
depreciation (v = 15)	(193)
Hauler	488
depreciation (v = 15)	(50)
Echosounder	127
depreciation (v = 12)	(16)
Various other equipment	
depreciation (v = 15)	
Total value of equipment	5 956
depreciation	(497)
- as percent of total value	8%

The depreciation figure in Table 10 is calculated by using the formula described above. Tables 11 and 14 provide further details. In calculating the value of equipment, we have excluded equipment used for swordfishing. There are two boats in the sample that are equipped with two engines each. Since the second engine is installed for swordfishing, we have included only one engine in our calculation. Likewise we have excluded the second of two haulers on one boat, as this is used for swordfishing.

In conclusion, we note first that three of the four inshore vessels, for which the two samples overlap, show a positive economic rent for 1984, amounting to 7, 13 and 15 percent of gross revenue, respectively. The fourth vessel shows a loss. One should, of course, avoid to draw strong conclusions on the basis of such a small sample, but the result indicates, as far as it goes, that inshore vessels that are operated efficiently on a full time basis are capable of yielding a positive economic rent.

The calculations for the two samples of vessels combined indicate that the profitability of the inshore fishery is marginal; the economic rent per vessel is negative but hardly significant. The inshore fleet as a whole thus appears to have just about broken even in 1984.

In comparison with the trawler fleet, the inshore fleet appears to be less profitable. Only the most ,efficiently run inshore vessels appear to yield some economic rent, which is less, however, than that of the average trawler. Again, it may be pointed out that the economic rent of the trawler fleet may be inflated by the low value of the vessels; a fleet consisting of new vessels might not yield any economic rent at all.

6.5 Rents in the marketing sector

It is possible that the story of economic rent in the fisheries is not fully told by looking only at the profitability of the fishing industry. As mentioned in Chapter 5, there is some indication of cooperation among the fishmongers. Such cooperation, for the purpose of "managing" the market, may enable the fishmongers to obtain some economic rent, in the following way. Restricting the amount of fish bought from fishermen makes it possible to charge higher prices as the fish is sold to restaurants, consumers and retailers, and to pay lower prices to fishermen because of increased competition among them. This leaves fishmongers with a profit margin over and above what they could earn in a different trade. Hence costs and revenues are no longer equal in the fishing industry, if we include trading in fish. The economic rent (apart from fishermen's skill rents which we ignore in this report) would all be collected by the fishmongers through their ability to control the market.

However this may be, it should be recognized that market power being held by fishmongers does not only have income-distributional implications; in free-access fisheries it does in fact have positive allocative effects. This comes about through the tendency to limit the quantity of fish being bought. The primary purpose may indeed be one of maintaining high prices, but at the same time it limits the catches that are being taken and thus conserves the fish resource, counteracting the tendency of the free-access fishery to overexploit.

Table 12

Catch and number of working days for a sample of inshore boats

Boat No.	Catch (okes)	Value (£)	Working days
1	3 360.5	11 153	172
2	2 691.5	8 376	188
3	2 618.5	7 301	172
4	3 041.5	10 974	122
5	2 983.0	6 906	201
6	3 254.0	13 141	159
7	2 915.0	10 131	165
8	2 597.0	7 208	109
9	2 058.5	6 030	187
10	2 988.5	8 682	152
11	2 577.0	7 319	113
12	2 200.0	8 793	93
13	5 429.5	14 324	168
14	3 936.0	12 210	281
15	4 517.0	12 512	295
16	4 163.0	10 611	211
17	3 022.0	9 920	270
18	4 142.5	13 208	264
19	2 917.0	8 192	141
20	2 574.5	8 195	197
21	2 785.0	8 687	203
22	4 237.5	11 904	193
23	1 988.5	6 328	211
24	2 600.5	5 907	229
25	4 967.0	10 496	227
26	2 200.0	7 006	249
27	1 927.0	5 613	232
28	2 759.5	8 355	219
29	2 976.5	10 604	109
30	2 934.5	9 389	169
31	2 100.0	4 738	120
32	2 949.5	9 855	207
33	2 098.5	5 828	129
34	2 074.5	4 967	120
35	2 061.5	6 035	187
36	3 932.0	12 287	281
37	2 997.0	8 658	152
38	2 200.0	8 793	93
39	2 590.0	7 350	113
40	5 430.0	14 322	187

Table 12 (continued)

Boat No.	Catch (okes)	Value (£)	Working days
41	3 022.5	10 100	270
42	4 142.5	13 207	264
43	3 932.0	12 287	281
44	4 509.5	12 799	295
45	4 153.0	10 592	211
	141 555.0	421 293	8 611
Average		9 362	191

Table 13

Frequency distribution of the number of working days for the sample of 45 inshore boats, and assumed percentage of full-time fishing

Number of working days	Number of boats	Percentage of full time	Number of man-years
> 240	9	100	18.0
200 - 240	12	90	21.6
160 - 200	10	75	15.0
120 - 160	8	60	9.6
80 - 120	6	40	4.8
	45		69.0

Table 14

Estimated annual running costs and value of a sample of inshore vessels

No of boat	Length	Engine HP	Value of hull	Value of engine	Value of hauler	Value of echo-sounder	Value of various outfit	Gear cost per year	Repairs, maintenance, per year
FLL 621	23'	16	1,670	1,130	360	90	500	800	460
FL 482	24'	20	1,500	3.060	290	230	500	800	460
FL 461	25'	22	1,950	1,610	290	230	600	900	460
FL 616	26'	32	2,170	1,180	360	90	600	1,000	460
FL 600	30'	33	2,960	1,710	210	90	600	1,500	460
FL 470	27'	22	1,860	1,300	1,440	70	600	1,200	310
FP 518	30'	33	2,630	1,410	300	80	600	2,000	420
FP 433	28'	33	1,890	2,630	260	60	600	1,000	420
FLL 543	27'	28	2,200	990	320	100	600	500	480
FLL 745	28'	33	2,240	2,600	300	80	600	600	580
FP 970	30'	33	5,780	3,250	1,700	250	600	600	580
FP 135 1/	34'	36/33	6,210	2,760	360	150	700	400	710
FL 605	22'	22	880	890	300	80	600	200	350
FL 707 1/	37'	75/75	6,600	5,620	1,890	80	700	2,000	510
FP 766	25'	22	2,150	2,470	610	230	600	500	330

1/ These are equipped with two engines each, presumably because of swordfishing. We assume that only one is required for the inshore fishery. In addition, FP 707 has two haulers, one valued at £ 1,050 is used for swordfishing

7. OPTIMUM EFFORT IN THE CYPRUS FISHERIES

7.1 Maximum sustainable rent effort

Having estimated the cost of fishing effort, we are able to calculate the optimum fishing effort. These calculations are based on a production model estimated by Garcia and Demetropoulos (1986, "Method 2").

Garcia and Demetropoulos use the Schaefer model. In this model, the catch per unit of effort, y, is a linear function of effort, E, i.e.:

$$y = a - bE,$$

and marginal sustainable catch of effort, m, is also linear and twice as steep:

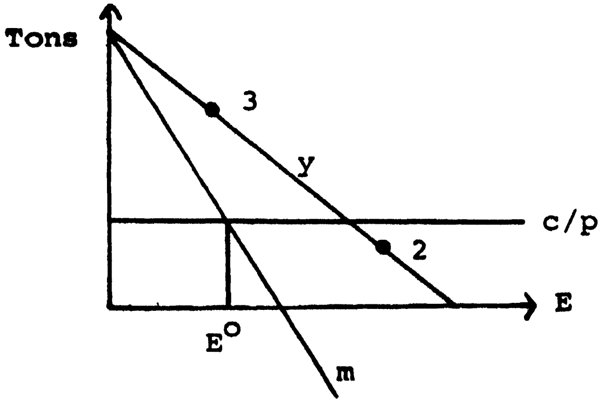
$$m = a - 2bE.$$

The economically optimal yield and effort (E^o), when there is no discounting, is determined by setting the value of the marginal yield equal to the marginal cost of effort. With a constant marginal cost of effort, c, and a constant price of fish, p, we get

$$pm = c, \quad \text{or} \quad m = c/p,$$

as illustrated in Figure 2.

Figure 2. Optimum yield and effort



Garcia and Demetropoulos show catch per unit of effort per square mile for two sets of areas, labelled A and B, each set containing two areas assumed to be characterized by the same catch per unit of effort function. As an example, assume that Figure 2 shows the productivity functions (y and m) for area set A. Points 2 and 3 then illustrate the y and E configuration for sub-areas 2 and 3, contained in area set A. The optimal effort per square mile of area set A is E^o, one half of the effort at which the line c/p intersects the catch per unit of effort line (y). Total optimal effort is then found by multiplying the optimal effort per square mile by the size of the areas contained in set A, and similarly for set B. Figure 9 in Garcia and Demetropoulos, reproduced here as Figure 3, shows the catch per unit of effort as a function of effort for area sets A and B.

To find c/p, we first use the aggregate cost data. In Chapter 6, Table 5, we found that the total cost of the fleet was £ 3 210 897 in 1983 and £ 3 930 280 in 1984. To find c, we divide by the total effort, which was 86.2 thousand inshore fishing days in 1983 (Garcia and Demetropoulos, 1986) and 99.3 thousand inshore fishing days in 1984. The latter figure has been calculated by us through finding the number of working days per ton of fish caught by the inshore fleet, multiplying this by the catch taken by the trawlers in Cyprus waters, and adding the result to the number of fishing days of inshore vessels. This gives c = 37 249 as a cost per thousand working days in 1983, and c = 39 580 for 1984.

It remains to find p. For this we used the average price of the catch from Cyprus waters in 1983 and 1984, calculated simply by dividing the value of the catch by its volume (tons). This gave p = 1 723 for 1983 and p = 2 006 for 1984, or c/p = 21.62 and c/p = 19.73 for 1983 and 1984, respectively. The term c/p expresses the cost per thousand inshore fishing days in terms of tons of fish, which is the unit of measurement utilized by Garcia and Demetropoulos for expressing catch per unit of effort.

Since changes in the level of fishing effort are likely to proceed by changing the number of inshore vessels, it is important to check this with the cost data for the inshore vessels. In Chapter 6 we presented two sets of cost calculations for the inshore vessels, one for a very small sample of four vessels operated on a full-time basis (Table 8), and another for a larger sample of 15 vessels (Table 10). The total number of working days for the four vessels in the small sample is 943, while their total costs amount to £ 45 902, which gives a cost per thousand working days of c = 48 677. The average price of fish in the inshore fishery in 1984 was p = 2 302 per ton (calculated from Table 2 in the Annual Report on the Department of Fisheries and the Cyprus Fisheries). This gives c/p = 21.15, a figure which is quite close to the ones found for the aggregate fishery.

As a further check, let us look at the cost data of the sample of 15 vessels. This sample includes some vessels that apparently are not operated on a full-time basis. In Table 10 we calculated the average cost of these vessels as having been £ 9 429 in 1984. With 191 working days per vessel (Table 12), this comes to £ 49 366 per thousand working days. Dividing by the price of fish in the inshore fishery in 1984 (£ 2 302 per ton) gives c/p = 21.45. Even this figure is quite close to the ones found for the aggregate fishery. It appears reasonable, therefore, to assume a cost per unit of effort (c/p) of about 20 tons per thousand working days for the inshore fishery, or 20 kg per working day, to put it differently.

Imposing a horizontal line at y = 20 on Garcia and Demetropoulos Figure 9 (reproduced here as Figure 3) makes it possible to find the optimum fishing effort per square mile for the areas represented in the figure. This line intersects line A_2 (representing areas 2 and 3 under the new management regime) at E = 0.21. The optimum effort is one half of this, or E^o = 0.105, 105 fishing days per square mile. The intersection with the curve labelled B_2 (representing areas 1 and 4 under the new regime) occurs at E = 0.35, implying an optimal level of effort of E^o = 0.175, 175 fishing days per square mile.

The table below compares the optimal level of effort with the recent level of effort. From this it can be seen that the optimum effort is less than the 1983-84 average in areas 1 and 2, but greater in areas 3 and 4.

Table 15

Fishing effort in thousand inshore working days per square mile

Area	Average 1983-84	Optimal	Optimal in percent of average 1983-84
1	0.34	0.175	51
2	0.26	0.105	40
3	0.07	0.105	150
4	0.07	0.175	250

To find the total optimum effort we multiply the optimum effort per square mile by the size of each area (Garcia and Demetropoulos, 1986, page 16):

Area	Size in square miles	Optimal effort per square mile	Optimal effort, thousand fishing days	Average effort 1983-84	
				per square mile	thousand fishing days
1	13	0.175	2.28	0.34	4.42
2	248	0.105	26.04	0.26	64.48
3	195	0.105	20.48	0.07	13.65
4	51	0.175	8.93	0.07	3.57
	107		57.73		86.12

The optimal effort thus appears to be well below the recent level, or 67 percent of the 1983-84 average, and still less, or 58 percent of the 1984 level (99.3 thousand fishing days).

If labour cost is set at zero, the cost per thousand days in the inshore fishery would fall dramatically, or to £ 16 613 (calculated from Table 10). This would produce c/p = 7.22, implying that the optimal effort per square mile exceeded even the 1983-84 average in the heavily exploited areas 1 and 2.

The effect of attaining optimal effort on economic rent can be calculated, again using Figure 3:

Area	Optimum catch per unit of effort (tons)	Economic rent per cpue/ square mile	Size of area per cent of total	Optimal effort
1	26	6/26	2.56	2.28
2	23	3/23	48.92	26.04
3	23	3/23	38.46	20.48
4	26	6/26	10.06	8.93

Economic rent, as percent of revenue for all areas, can be found from the above table (sum column 3 x column 4) to be 14.3 when effort is optimal. The optimal effort would give a total catch of 1 360 tons (sum column 2 x column 5). This can be compared to the catch from Cyprus waters in recent years (tons). (Source: Reports on the Department of Fisheries and the Cyprus Fisheries.)

1980	1981	1982	1983	1984
1 038.3	1 074.9	1 153.4	1 703.9	1 951.6

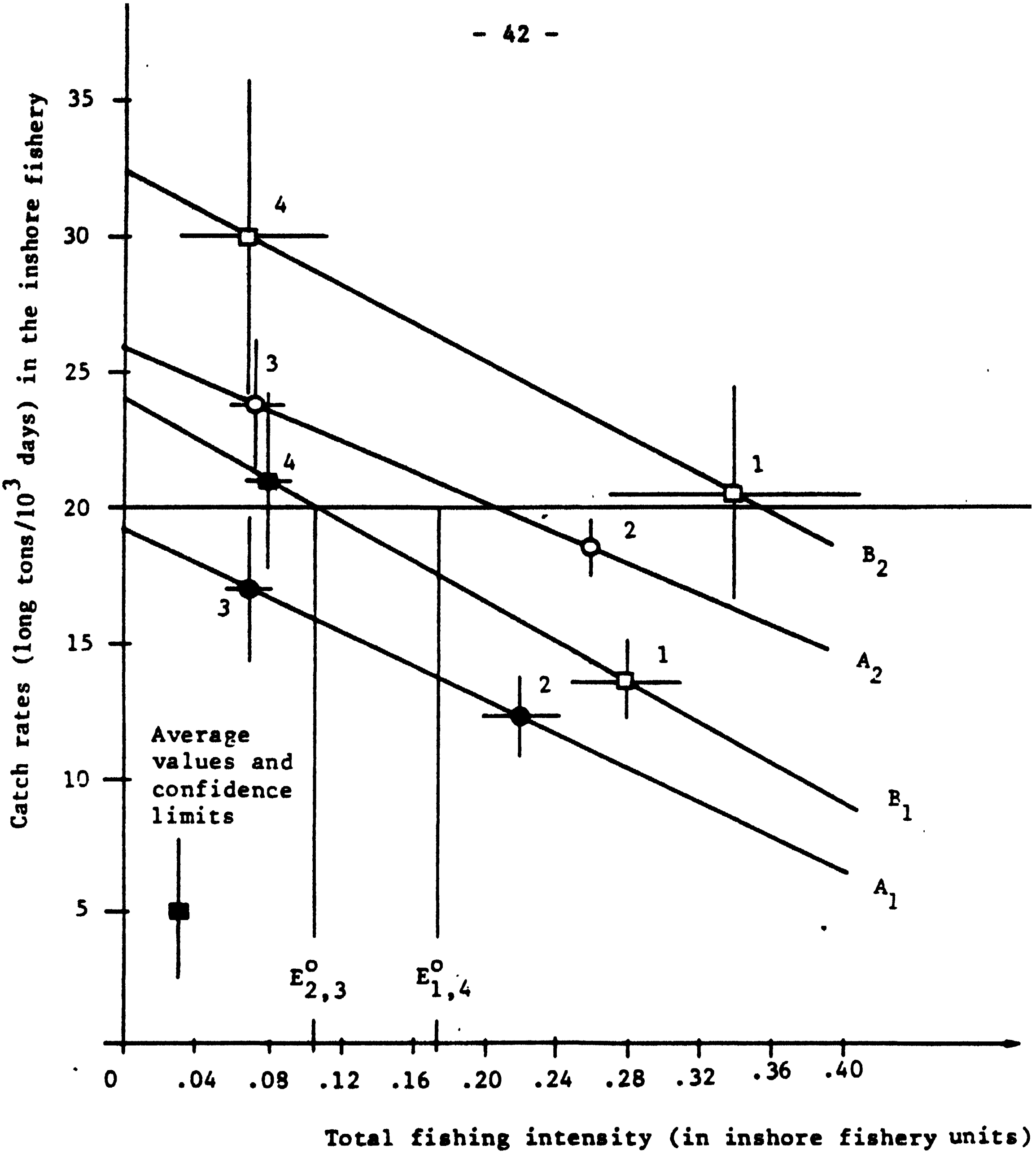


Figure 3. Relationship between catch rates and fishing intensity in areas heavily trawled (2 and 3) and lightly trawled (1 and 4) before and after the extension of the closed season:

A_1 and B_1: before extension

A_2 and B_2: after extension

7.2 Maximizing the present value of rents

Even if maximization of economic rent is a legitimate objective, maximization of sustainable rent need not be. Looking only at sustainable rent ignores the aspect that fish resources are assets, on which it would seem appropriate to require a certain rate of return, as for any other capital asset. After all, society may invest in fish by refraining from fishing and so increase the fish stock, for the purpose of obtaining a greater yield, or a higher profit, later on. Requiring that this kind of "investment" yield a return comparable to other investments implies that we should be looking at the present value of the stream of future economic rents, and not just annual economic rent on a sustainable basis, with the rate of discount reflecting the required rate of return on capital. It is well known that maximizing the present value of future rents implies a higher optimal level of effort than a maximization of sustainable rent, provided that the cost of fishing effort is the same in both cases. We shall now investigate by how much maximization of the present value of rent is likely to increase the optimal level of effort, compared to maximizing sustainable rents.

It is not possible to fully account for the impact of discounting on the optimum level of effort unless we have a specified growth model of the resource. This we do not have. By guessing at the value of a few strategic parameters, however, it is possible to get an idea of how important a factor discounting is in determining the optimal level of effort.

The Schaefer model, which Garcia and Demetropoulos use, assumes that catch, y, is a function of fishing effort, E, and biomass, W, as follows:

(1) $y = EqW$, q constant.

The total cost, TC, is

(2) $TC = cE$, c = cost per unit of effort.

The cost per unit harvested, TC/y, thus is

(3) c/qW.

Maximizing the discounted stream of profits entails the following:

(4) $\text{Max} \int_0^\infty [(c-p/qW)H]e^{-rt}dt$,

where p is the price of fish, H is the amount harvested, and r is the rate of discount.

If $G(W)$ is the growth function of biomass and $W = dW/dt$, we have

$$(5) \qquad H = G(W) - W.$$

Substituting (5) for H in (4), using Euler's necessary conditions for maximizing the functional in (4), and looking only at steady-state solutions, gives

$$(6) \qquad r - G' = \frac{\overset{H}{\bar{p}}}{qW-c/P}.$$

Ignoring discounting and maximizing sustainable rents, as we did above, amounts to setting $r = 0$ in equation (6). To see the magnitude of error that will arise from this, we try to find the likely magnitude of G' at the optimum effort level. Above we assumed that c/p was close to 20, while qW, which is the catch per unit of effort at the optimum, was found to be 26 for areas 1 and 4, and 23 for areas 2 and 3. The denominator of (6) therefore is 3 and 6, respectively.

The term H/W is the proportion of the standing stock of biomass that is harvested every year. Suppose this is equal to one half, we then have

$$- G' = \frac{20 \times \frac{1}{2}}{23-20} = 3.33 \quad \text{area 2 and 3}$$

$$- G' = \frac{20 \times \frac{1}{2}}{26-20} = 1.67 \quad \text{area 1 and 4}$$

It thus seems that G', the slope of the tangent of the growth curve at the undiscounted optimum, is likely to be -1 or less. Adding a 10 percent discount rate on the left side of (6) will thus change the left side by 10 percent or less. This will lead to some adjustment of W, and the largest effect of that will be in the demoninator on the right hand side of (6). A 10 percent change of the right hand side of (6) will be produced by decreasing the catch per unit of effort to 25.5 and 22.75. The resulting percentage change in optimum effort, using Figure 3, is about 4 percent for all areas.

As a further illustration, consider a version of the logistic growth model (Garcia and Demetropoulos' model is based on the logistic growth model). Suppose the growth function for the fish resources in Cyprus waters is:

$$(7) \qquad G(W) = 2W(1-W),$$

so that

$$(8) \qquad G'(W) = 2(1-2W).$$

Setting $G(W) = H$, substituting (7) and (8) in (6), and dividing by H/W, gives

$$(6') \qquad \frac{r-2(1-2W)}{2(1-W)} = \frac{c/p}{qW-c/p}.$$

For areas 1 and 4, the right hand side of equation (6') is $20/(26-20) = 3.33$, while for areas 2 and 3 it is $20/(23-20) = 6.67$. From this we can calculate the optimum stock level and equilibrium yield. This yields the following results:

	Areas 1 and 4		Areas 2 and 3	
	W^o	$G(W^o)/W^o$	W^o	$G(W^o)/W^o$
$r = 0$	0.812	0.3760	0.885	0.2300
$r = 0.1$	0.803	0.3940	0.879	0.2420

Since $H = G(W) = EqW$, where E is fishing effort, the increase in effort implied by raising the discount rate from zero to 10 percent is the same as the increase in $G(W)/(W)$. This is approximately 5 percent in both cases, which agrees quite well with our reasoning above. Raising the maximum relative growth rate (the parameter "2" in equation (7)) would reduce the increase in effort implied by a 10 percent discount rate.

Hence, our previous conclusion regarding optimum effort in the Cyprus fishery is little affected by maximizing the present value of rents instead of undiscounted rents. The optimal effort in the Cyprus fishery thus is not likely to be much higher than 60 thousand inshore fishing days, which is about 70 percent of the 1983 level of effort, and 60 percent of the 1984 level.

7.3 The effects on yield and rents of achieving optimum effort

Above we found that optimum effort (undiscounted) would raise economic rent from its present level of near zero to about 14 percent of gross revenue. The catch would not increase, however, from its current level; the total catch using optimum effort would be no more than 1 300-1 400 tons. This is considerably less than the exceptionally high catches in 1983 and 1984, after the closed season in the trawl fishery was extended, but more than the catches taken in Cyprus waters in 1980-82. The optimum yield thus is less than the maximum sustainable yield. With the cost per unit of effort being as high as it appears to be, in relation to the value of fish taken by an additional unit of effort, it is simply not worthwhile to engage all the effort necessary to produce maximum sustainable yield. As discussed in Chapter 2, finding the optimum yield and effort involves comparing the value produced by an additional unit of effort with the cost of that unit. An additional unit of effort may indeed add to the total yield without being a worthwhile undertaking, according to this criterion.

7.4 A gradual approach to optimum effort

How, then, is the optimum effort to be approached? Should effort be reduced immediately by 40 percent of its 1984 level and, if so, how? Let us first of all stress that this figure should primarily be taken as indicating the direction in which one ought to be going. The figures on which the calculation of optimum effort is based are so uncertain that the result cannot be taken as a very precise estimate. This uncertainty applies to both the economic and biological calculations. In the preceding chapter we showed how the cost figures were derived. Some are based on samples that to some extent are prone to be biased and unrepresentative, while others are informed guesses. The biological model, on which we have grafted our economic reasoning, also has its weak points, which the biologists are in a better position to appreciate and explain.

There is another reason for proceeding with some caution in reducing the level of effort from its present level. This stems from a certain asymmetry in the cost per unit of effort. New fishing effort is generated by buying new boats and recruiting additional fishermen. This new effort, therefore, costs whatever is the cost of new vessels, plus the value that the newly recruited fishermen would produce in an alternative occupation. This is, in principle, the cost we have been trying to measure. On the other hand, withdrawing fishing effort means retiring boats and equipment for which there is little or no alternative use, and laying off fishermen who possibly do not possess the skills needed for alternative employment. The cost of effort when it is being reduced - that is, cost that is being saved - thus is less than the cost of expanding effort.

The cost difference between expanding and contracting effort cannot, however, persist indefinitely, as fishing equipment sooner or later must be renewed and retired fishermen replaced by recruiting new ones. But this difference is important in the short and intermediate run; important, that is, for the speed at which effort is being reduced. If the cost savings of reducing fishing effort are negligible, then the effort reduction should be accomplished through the process of wearing out equipment and retirement of fishermen. In this present case of Cyprus' fisheries, if there were no alternative employment for the present fishermen, the cost per unit of effort in the inshore fishery would drop to about one third of the value we have estimated, implying that the present level of effort was close to or even less than optimal. Thus, if it were a reasonable assumption that alternative employment for Cypriot fishermen does not exist, then there is no case for an immediate reduction of effort in the inshore fishery, while there is a case for preventing that it increases further. Over time the effort should, in that case, be reduced through the retirement of fishermen.

7.5 The first step: stopping the expansion of effort

What seems beyond doubt is that steps should immediately be taken to prevent further expansion of the inshore fishing effort. As discussed in Chapter 5, there is a clear indication that fishing effort has been expanding recently in the inshore fishery, probably in response to improved profitability due to the extended closed season for trawling. This development certainly adds to the urgency of freezing the present number of licences and reversing the trend. All experience indicates that it is difficult to reduce excessive fleet capacity once it has been put into place. In addition there is the once and for all deadweight loss associated with the development of such excess capacity. These are two weighty reasons for preventing that kind of development from occurring.

With regard to reducing excessive effort, there are at least two reasons for doing so gradually instead of plunging for an immediate 40 percent reduction. One is the possible absence of alternative employment for those who would leave the fishery. The other is the uncertainty of the biological model and economic parameters used for calculating the optimal effort. A close monitoring of a gradual reduction in effort would affirm or refute the predictions of the model, and a new and more reliable calculation of the economic optimum could be undertaken in the light of such findings. In the next chapter we discuss, in greater detail, the approach to reducing and controlling effort.

8. THE CONTROL OF FISHING EFFORT

8.1 Individual catch quotas

In Chapter 3 we discussed the principal means of controlling effort, concluding that individual transferable quotas had a clear advantage in theory over effort licences and taxes. It was recognized, however, that practical considerations might make individual catch quotas a less attractive proposition than effort licences. These practical considerations had to do with variability in catches, diversity of species caught, and difficulties in monitoring.

The latter two are clearly relevant for the Cyprus fisheries. Inshore fishermen catch a multitude of species; the catch statistics compiled by the Department of Fisheries lists 27 species being caught by the inshore fishery. Only two of these, voppa (Boops boops) and marida (Maena smaris) can be targetted for by using special gear in particular places at certain times of the year. Apart from that, the inshore species are caught indiscriminately and there may easily be fish of 10 to 20 species in each catch. This would make the use of species-specific catch quotas in the inshore fishery a cumbersome and unwieldy undertaking, for fishermen and fisheries management alike. An overall quota for all species would be easier to administer, but would at the same time create a new problem. Since the price (ex-vessel) of the inshore species varies quite considerably (Chapter 5), an overall quota would create incentives for fishermen to throw away the least valuable species in order to reserve the quota for the more valuable ones. This might, in fact, increase the pressure on the fish resources.

Another reason why individual catch quotas do seem to be of limited relevance for the Cypriot inshore fishery is the incentive they would generate to under-report catches, coupled with difficulties in monitoring the quotas. At the present time the catch is landed in 18 fishing shelters, and most of it is bought first-hand by some 24 fishmongers. The problem of monitoring does not seem overwhelming, given the limited number of landing points and wholesalers. On the other hand, fishermen would have an incentive to sell their fish directly to restaurants and consumers, or get fishmongers to collude in under-reporting the catches. Such collusion is made easier by the high number of species involved and the small quantity caught. At present some fishermen sell their catches directly to consumers and restaurants, and more would be expected to do the same if the incentive to do so were stronger.

Individual catch quotas thus do not seem to be the best way of limiting effort in the inshore fishery. They might possibly be practised with respect to the two species that can be targetted on (voppa and marida), to the extent a special need is felt for protecting these species. Transferable quotas could also be used for regulating the trawl fishery, the catches of which are carefully monitored.

8.2 Boat licences

We then turn to examining the second major method of controlling fishing effort, the licensing of fishing boats. The main drawbacks of this method have already been discussed. Here we note two important points. First, it is difficult to control all the dimensions of effort, and it is prone to expand along its uncontrolled dimensions. Secondly, controlling only some dimensions of effort will distort the cost-minimizing choice of combining the various components of effort. In devising a licensing system for the inshore fishery, care must be taken to avoid these traps as far as possible. The first and most immediate problem to avoid is the expansion of effort along uncontrolled dimensions.

One would suspect that licensing boats only would not be enough as new and larger boats with stronger engines and space for more fishing gear could be acquired on the basis of a licence to operate a fishing boat. If this is so, then a licensing system specifying either the size of the boat or that of its engine, and possibly both; would be required. As an alternative, each particular boat could be licensed to carry a certain amount of fishing gear. This system is obviously more difficult to control than one based on the characteristics of the boat itself.

There is some empirical evidence on the relationship between the size of the inshore boats and the catch. Figure 4 shows the catch per working day of some 32 inshore boats in 1984 and the size of each boat. There is hardly a significant relation between the two; the correlation coefficient between boat size and catch per working day is only 0.44, while the critical value is 0.35, 0.45 and 0.55 at the 5, 1 and 0.1 percent level of significance, respectively. This indicates that the size of a fishing boat, within the actual size range in the inshore fishery, may not be all that important for its fishing power. This would, if it is true, greatly simplify the licensing system needed for the inshore fishery, as it would be sufficient to issue boat licences without worrying about the size or other characteristics of the boats. Perhaps the system could be started by issuing licences for boats only, reserving the option of introducing a more elaborate scheme later, in case fishermen respond by buying larger and better equipped boats, and a significant correspondence is verified between the size of a boat, or any other of its characteristics, and its fishing power.

If there is little scope for expanding fishing effort along uncontrolled dimensions, there is not much to worry about with respect to distorting the choice of cost-minimizing combination of inputs, for the existing technology. Innovations are, however, technological surprises by their nature. Innovations might therefore make existing licensing schemes obsolete, or at any rate necessitate some modification. From an economic point of view, it is important that innovations be accommodated in a way that allows society at large to reap the benefits of a cost-saving, new technology. A case in point are the monofilament nets now being introduced in the inshore fishery. These, we are told, catch more fish than traditional nets of a similar size. Thus, if monofilament nets were introduced on all fishing boats, the fishing power of the licensed fleet would increase, and fishing effort would expand along an unlicensed dimension. There are two ways of preventing such an expansion of fishing effort. One is to ban the use of monofilament nets, the other is to reduce the size of the fishing fleet as needed to

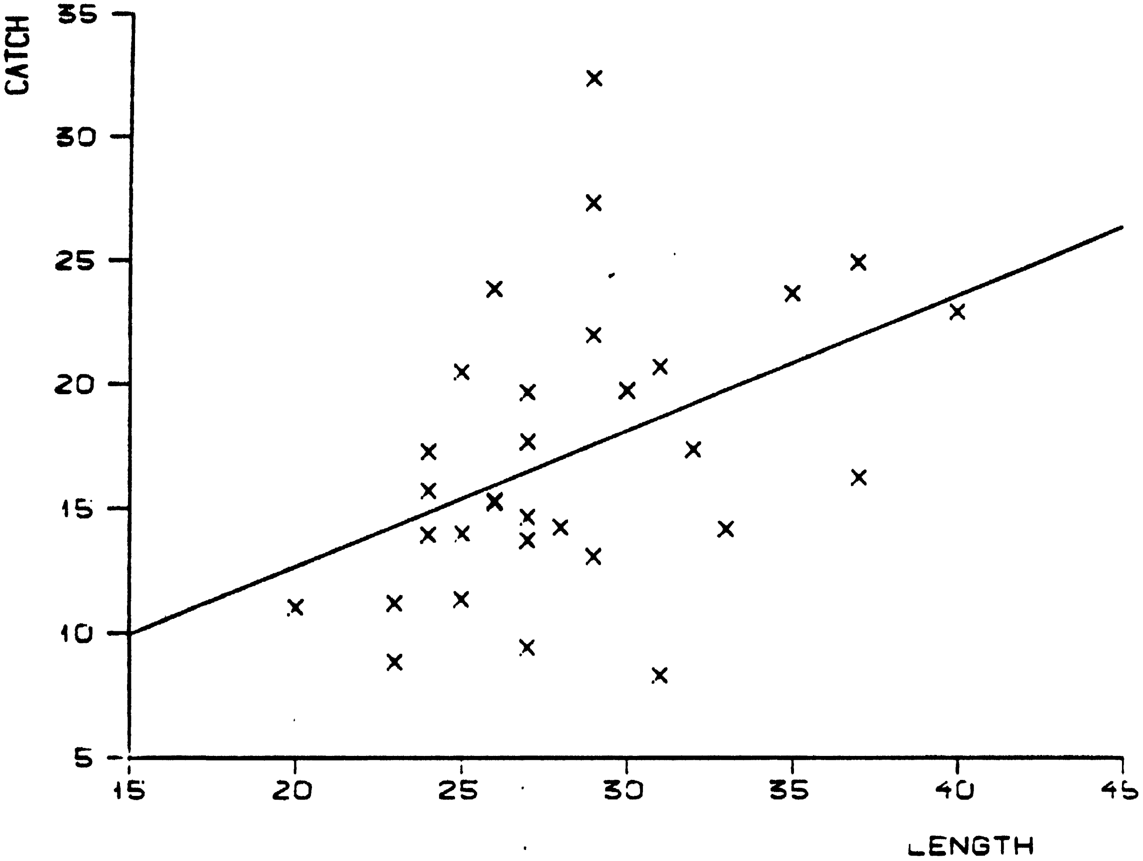


Figure 4. Relation between the catch per working day, Y, and the length (in feet), X, of a sample of inshore boats. The equation of the regression line is

$$Y = 1.7438 + 0.5455X$$
$$(0.2975)\ (2.6671)$$

(Numbers in parenthesis are t-values)

Table 16

Length, catch, and number of working days for a sample of inshore fishing boats, 1984

Length	Catch (okes)	No. of working days	Catch per working day
20'	2 062	187	11.03
25'	3 932	281	13.99
30'	2 997	152	19.72
35'	2 200	93	23.66
40'	2 591	113	22.93
29'	4 237	193	21.95
27'	1 988	211	9.42
25'	2 600	229	11.35
25'	4 697	227	20.48
23'	2 200	249	8.84
31'	1 927	232	8.31
23'	3 022	270	11.19
30'	4 163	211	19.73
29'	2 976	109	27.30
32'	2 934	169	17.36
28'	2 949	207	14.25
37'	2 098	129	16.26
26'	4 517	295	15.31
24'	2 074	120	17.28
27'	2 915	165	17.67
26'	2 598	109	23.83
24'	4 142	264	15.71
27'	3 382	172	19.66
24'	2 623	188	13.95
29'	5 429	168	32.32
26'	2 619	172	15.23
37'	3 041	122	24.93
27'	2 946	201	14.66
33'	2 254	159	14.18
31'	2 917	141	20.69
29'	2 574	197	13.07
27'	2 785	203	13.72

accommodate the new nets. Only the latter method permits society to take advantage of the new technology. This takes place through decreasing the need for manpower and capital in the fishery, leaving more of productive resources to be used in the rest of the economy.

8.3 Limitation of effort through excluding occasional fishermen

How, then, should a licensing scheme be implemented? In Chapter 4 we discussed how this could be done without harming those who are engaged in the fishery at the time the licensing scheme is put into effect. The starting point is to issue licences to all fishermen at the time the scheme is introduced, confirming their right to fish as they have in the past. Since all Cypriot fishermen must have a licence, all that is needed for a start is a restrictive practicing of the system; that is, no new licences should be issued.

Freezing the number of licences accomplishes nothing more, however, than fixing the level of effort at its present level, at the best of times. Provided licences are not transferable, the approach towards the optimum level of effort will take place through the retirement of fishermen. This will be a long and drawn out process and hardly recommendable for a full employment economy where fishermen have other employment opportunities. In our general discussion of licences we mentioned so-called buy-back schemes as having been designed to reduce the amount of fishing effort without going against the interests of those who are engaged in the fishery at the time restrictive licensing is introduced. Another way which has been suggested for the Cypriot inshore fishery is excluding the so-called occasional fishermen. We consider this last-mentioned method first.

In 1984 the total number of vessels in the inshore fishery was 548; 210 full-time vessels, 115 part time, and 223 occasional. The Department of Fisheries assumes that part time boats are occupied 75 percent of the time of full-time boats, and occasional boats 25 percent of the time (Annual Report on the Department of Fisheries and the Cyprus Fisheries, 1983). This implies that the effort of the occasional boats is only 16 percent of the total effort of the inshore fishery, or approximately 12 percent of the total fishing effort including trawlers. Eliminating the occasional boats would thus be an important step towards eliminating excessive fishing effort, but probably no more than that, as our calculations indicate that effort must be reduced by no less than 40 percent of its 1984 level. There are, however, important distributional and allocative arguments against excluding occasional fishermen. To take the distributional aspect first, the fish resources around Cyprus may certainly be viewed as recreational resources as well as a basis for a commercial fishery. Presumably, occasional fishermen seek recreation just as much as a narrow economic gain. But since occasional fishermen are a group distinctly different from those who earn their living from fishing, there is a conflict between the two as to who should have access to the resources.

The recreational demand for access to the fish resources could, it seems, be accommodated by allowing occasional fishermen to fish for their domestic needs. An allocative argument may, however, be advanced in favour of letting occasional fishermen supply the market, to the extent they are willing to. Presumably, occasional fishermen put a low value on the time they use for fishing, as this is done partly for recreational purposes. Some occasional fishermen may also be engaged in seasonal work and unable to use the time they spend fishing for any other employment. The cost to society, in terms of foregone production, of having occasional fishermen supply the market, is thus likely to be low. Furthermore, occasional fishermen would save the labour of some full-time fishermen, making it available for other sectors of the economy.

8.4 Effort limitation through a buy-back scheme

Let us then consider a buy-back scheme. This is not only an alternative to excluding occasional fishermen; a buy-back scheme will probably be needed anyway. In part this is because optimum effort will require a larger reduction than can be achieved by the exclusion of occasional fishermen. In part, also, the buy-back scheme will be necessary to accommodate technological progress. We have already described (Chapter 4) at some length how such schemes work in principle. One of the points stressed in that discussion was that a buy-back scheme can be financed out of the rents generated by limiting effort. It will, however, be necessary for the government to advance funds to get the system going, as it takes a certain time for the profits of a buy-back scheme to materialize. In Cyprus, that time should not be more than two to three years, because of the high turnover rate of biomass in the warm Mediterranean waters.

To ease the fiscal burden of the buy-back scheme, the process could be spread over several years, instead of trying to approach the calculated optimum immediately. The uncertainty underlying the calculated optimum provides an additional argument in favour of a gradual approach. A tax on the emerging rents could then be used for financing the continuation of the buy-back programme, as well as for recovering the funds initially advanced to get it going.

8.5 Taxing the fishery rents

How, then, might the fishery be taxed in order to finance the buy-back scheme? As discussed in Chapters 3 and 4, there are two principal ways of doing this; one may either tax fishing effort or the fish itelf. As discussed in Chapter 3, there are allocative arguments in favour of taxing the fish rather than fishing effort. If a tax on fishing effort is not to distort the cost-minimizing choice of labour, capital and other inputs, all of these must be taxed in a non-distortionary way. For practical reasons, however, it is seldom possible to tax more than one or a few of the inputs. An example of such a tax is a licence fee. It is easy to see what kind of distortions this may give rise to. If a licence simply conveys a right to operate a fishing boat without any further qualification, the licencee will have an incentive to buy a larger and better equipped boat or to use more fishng gear and a larger crew than he would otherwise have done, in order to get as high a return as possible on his licence fee. The analysis of the catches of the inshore boats showed little relation between catch per working day and boat size, so this may not be a relevant problem for the inshore fishery. The possibility, however, of licence fees leading to the introduction of new types of boats, bigger, better equipped and with larger crews, should be kept in mind, and the option of changing the licensing system if this happens should be kept open.

The other method, taxing the fish, does not distort the choice of technology as a tax on effort is prone to do. From a distributional point of view, its effects are also different. A tax on the landings of fish affects fishermen in proportion to how much they catch, so that the good fisherman pays a higher tax than the poor fisherman. A tax on effort is different in this regard. Both the poor and the good fisherman will pay the same licence fee per boat, if the licence fee is specified per boat without any further qualification. Hence the good fisherman will end up paying a smaller share of his income for his licence.

Last, but not least, the choice between a tax on fish and licence fees depends on which of these is easier to administer and control. The fact that there are a limited number of fishmongers and landing places in Cyprus indicates that a tax on fish landed would neither be all that difficult to administer nor easy to avoid. Some fishermen do, however, sell their fish directly to consumers or restaurants, and they would have a stronger incentive to do so without reporting their catches, if there were a tax on the fish. This speaks against using a tax on fish to skim off some of the fishing rent. Since the size of fishing boats appears to be rather unimportant for how much fish they catch, it may very well be the case that licence fees would not produce any significant distortions in the choice of technology. Given that licence fees are simpler to administer and monitor than a tax on fish, licence fees probably are a better option.

Since the economic rents in the inshore fishery are only marginal at the present time, the licence fee (or tax on fish) cannot be put into effect immediately if the effort limitation scheme is to be put in place without reducing the incomes of the fishermen. Introducing licence fees, or a tax on fish, at a later date must however be firmly established as an option when the effort limitation scheme is established. When rents start to emerge in the fishery, the licence fee or tax can be put into effect and gradually increased as desired. A tax on economic rent in the fishery need not be implemented exclusively for the purpose of financing a buy-back scheme; it can also be used as a source of revenue for the government. Whether or not this should be done is a political question, as we have already discussed in Chapters 3 and 4.

8.6 The need to specify licences with respect to time spent fishing

In Chapter 4 we discussed the question of transferability of licences. This raises another issue regarding the specification of licences, that of full-time boats versus part-time and occasional boats. If licences are given to all of these without a further qualification and then made transferable, it is quite possible that fishing effort would be expanded through a prospective full-time fisherman buying a licence from a part-time or an occasional fisherman. Such expansion could, of course, also take place through part-time and occasional fishermen electing to devote more of their time to fishing, something which seems particularly likely to happen if the profitability of the inshore fishery improves. In order to avoid an undesirable increase in fishing effort along these lines, it is probably necessary to specify fishing licences in terms of the number of days, weeks, or possibly months that a licence is valid. Such a time limitation of the initial licences could be based, for example, on the average number of fishing days over the previous three years.

Another reason why it would seem to be desirable to specify licences in terms of time spent fishing is the possibility this provides for accommodating part-time and occasional fishermen. As previously argued, there are some allocative advantages of allowing people to combine part-time fishing with their main occupation, or to make it possible for those whose main occupation is fishing to do some other kind of work at certain times of the year. If licences are issued without any qualification as to time spent fishing, either of the following may happen. If the licence fee is low, even occasional fishermen will presumably buy a licence. But as it is difficult to know in advance how much of their time the licence holders will devote to fishing, the total amount of effort expended each year will not be so easily predictable, and it might deviate considerably from the optimality target. If, on the other hand, the licence fee is substantial, occasional fishermen might not find it worthwhile to acquire a licence. This last point argues in favour of differentiating the licence fee according to the length of the period the licence is issued for.

Part-time licences would, for practical reasons, have to be specified as to which time of the year a licencee were permitted to fish. Policing a licence which specified only the total amount of time allowed for fishing would make it necessary to keep records of how much time a licencee has spent, and would thus be costly to monitor and control. The greatest flexibility for part-time and occasional fishermen would be provided by allowing them to choose in which period to fish. The need to secure an even supply of fish may however, make it necessary to restrict this choice in some way, or to use licence fees that vary with the time of the year in order to influence fishermen's choice of when to fish.

8.7 Area-specific licences

Another qualification of the fishing licences, if the licensing system is to attain the desired distribution of effort, is to make them valid only for certain locations. Garcia and Demetropoulos (1986) conclude that a more even distribution of fishing effort between areas would be desirable, and our calculations of optimal fishing effort point in the same direction. To accomplish this it would be necessary to make each fishing licence valid only for a certain area. Policing this regulation would presumably mean more work effort for the Department of Fisheries and its fisheries inspectors, and the cost of that additional effort would have to be evaluated against the expected benefits from that kind of regulation. Since the inshore boats do not go very far from their home port, monitoring their landing places goes a long way toward controlling where they have taken their fish. Problems may arise in places close to the border between areas, making some patrolling at sea necessary. To make this easier, the boats could be required to display some clearly visible sign, indicating in which area they were allowed to fish.

8.8 Reducing the trawling effort

Above we have been concerned only with limiting the fishing effort of the inshore fleet. It is possible, however, to limit fishing effort through reducing the number of trawlers. Comparing the profitability ofthe trawlers and the inshore vessels, the trawlers seem to do rather better than the inshore vessels. It is, however, clear that the catches of the inshore vessels depend on the trawling effort; the effect of the extended closed season for the trawlers on the inshore fishery is a clear enough indication in that regard.

The profitability of the inshore fishery could possibly improve so much by closing the trawl fishery as to fully compensate for the loss of rents in the trawl fishery. The effects of closing the trawl fishery depend upon the biological interrelation between the trawl and the inshore fishery, as the trawlers fish juvenile fish which has not yet fully utilized its growth capacity. The problem needs to be further studied by biologists before any economic conclusions can be reached. Apart from this, a reason for retaining some trawlers is that this produces a more even supply of fish than would be the case if all of it came from the inshore fishery.

9. REFERENCES

Anderson, L.G., 1977. The economics of fisheries management. Baltimore, Maryland, Johns Hopkins University Press, 214 p.

Campbell, D., 1984. Individual transferable quotas: their role, use and application. Fish.Rep.Dep.Primary Prod.,Canberra, (11):30 p.

Garcia, S. and A. Demetropoulos, 1986. Management of Cyprus fisheries. FAO Fish.Tech.Pap., (250):41 p. Issued also in French

Hannesson, R., 1978. Economics of fisheries: an introduction. Bergen, Universitetsforlaget

____________, 1986. The regulation of fleet capacity in Norwegian purse seining. In Fishery access control programs worldwide: proceedings of the Workshop on management options for the North Pacific longline fisheries, edited by N. Mollett. Orcas Island, Washington, April 21-25 1986. Alaska Sea Grant Rep.Univ.Alaska, (86-4):65-83

Kirby, M.J.L. (ed.), 1982. Navigating troubled waters: a new policy for the Atlantic fisheries. Reportof the Task Force on Atlantic fisheries. Ottawa, Canada, Government Publishing Centre, 393 p.

Pearse, P.H. (ed.), 1982. Turning the tide: a new policy for Canada's Pacific fisheries. Vancouver, Canada, Commission on Pacific Fisheries Policy

NO: 111 71

$$\begin{array}{l} 57+11 \\ \hline 68 \end{array}$$